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POUR L'EXPLORATION DE LA MER
CHARLOTTENLUND SLOT – DANEMARK

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J. R. LUMBY

EN COMMISSION CHEZ
ANDR. FRED. HØST & FILS
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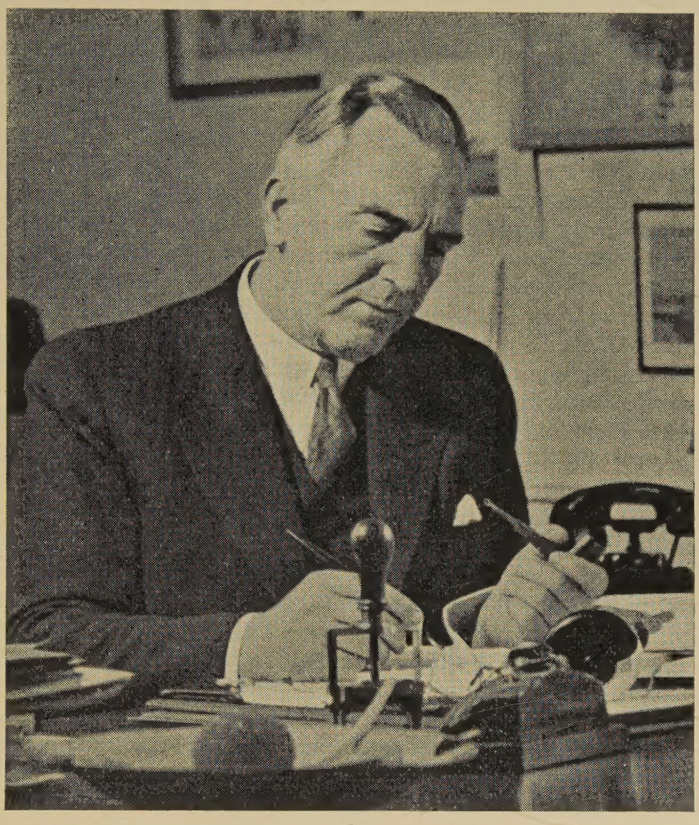


Harald Blegvad.

1886—1951.

ON the morning of 22nd August 1951, the news of Harald Blegvad's sudden death brought consternation and deep sorrow to his colleagues and friends. Few of us had thought that the life of this healthy and vigorous man should stop at as early an age as 65 years. As he rode his bicycle up one of the steep slopes on his way home from a visit to his father in law he was attacked by a heart failure, which caused instantaneous death.

Harald Blegvad was born in 1886 on the island of Samsø in the northern Belt Sea. Under the rural conditions of

this small island and with the sea close to his doors his interest in living Nature arose at an early age and, the child being father of the man, this interest widened and grew through the whole of his life. After he had matriculated at the University of Copenhagen in 1904 he took up the study of natural history. He became a Master of Science in 1910, and in 1921 he obtained his Doctorate on the strength of a paper entitled "On the Biology of some Danish Gammarids and Mysids".

As a young student he took part in the cruises of the "Thor" in Danish and Atlantic waters, and in 1908 he was appointed Assistant at the Danish Biological Station, a position he occupied until in 1931, on the death of A. C. Johansen, he was appointed Director of the Station. He has been a member of Kommissionen for Danmarks Fiskeri- og Havundersøgelser since 1931 and its Vice-Chairman since 1948.

From the year 1927 and onwards Blegvad regularly took part in the work of the International Council for the Exploration of the Sea. In 1931—32 he attended the meetings as expert and as Danish Delegate since 1933. From 1932 to 1946 he was Chairman of the Transition Area Committee. Through all these years, and especially through the difficult years of the second world war, he took a very active part not only in the scientific but also in the administrative work of the Council, and it was thus quite natural that in 1945 he was appointed General Secretary.

It was not only Denmark and the International Council, however, that made demands on Harald Blegvad's knowledge of fishery matters. On several occasions foreign governments asked him to come and organize, or re-organize, their fisheries. In 1928 he was in Lithuania as a fishery expert, for the Government of that country. In 1936 and 1938 he spent two winters organizing, for the Persian Government, the fishery in the Gulf of Persia, the transport of fish within the country, and the erection of plants for fish conservation. In the spring of 1949 he acted as fishery expert for Ceylon. In the course of years there were also other countries which asked for his help, but he had to refuse it, owing to the tasks laid upon him by the Danish Government and the International Council.

Harald Blegvad concentrated his scientific work mainly on the biology of the food fishes and the animals on which they feed. He thus took up and developed the work of his two predecessors, C. G. Joh. Petersen and A. C. Johansen. A long series of publications was the result of

his investigations. These papers bear evidence of his keen eye for the essential points of a problem and exhibit a sober self-criticism which is so indispensable to all true scientific work. Some may perhaps find his papers lacking a little in bold brilliancy, but the observant reader will see that the conclusions stated are true, and are based on a secure understanding of the value of the data at hand, combined with a vast knowledge gained by experience and reading.

Through his later years the extensive administrative work which B l e g v a d carried out for the Danish Biological Station and for the International Council took up a great part of his time, and he had to content himself with a lesser scientific activity. For all that, on the very last day of his life he delivered to the printers a paper dealing with just that topic which had been his favourite since his younger days, the dependence of fishes upon the animals on which they feed.

However, H a r a l d B l e g v a d was not satisfied with publishing his results in scientific papers, for the benefit of scientists alone. His interests and his aims went further; he published quite a number of popular articles in fishery periodicals, Danish as well as foreign, and also edited various handbooks on fishery matters. Through these publications he contributed largely towards the widening of the general understanding of the importance of scientific research to the fishing industry.

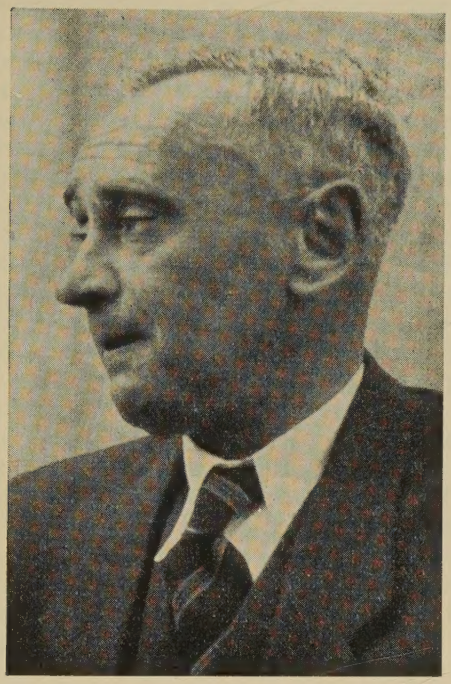
This activity accorded well with one of the outstanding features of B l e g v a d' s personality, his strong interest in and deep feeling for his fellow men. No other Danish fishery biologist knew — and knew so well — so many fishermen as he. He met them or sought them at their homes, just as they came to his and his wife's house. But first and foremost he met them in their boats. One must have seen him with the fishermen on the slippery, heaving deck, and in the cramped, rocking cabin sharing their meals and their bunks in order to understand what this companionship meant to the fishermen and to what degree it fostered not only their understanding of the work of the biologists, but also his own faculty for serving the interests of the fishery.

It was not only fishermen, however, who gained by H a r a l d B l e g v a d's fine, human character; we also, his collaborators and assistants, were among the beneficiaries. As a chief he was kind, helpful, and understanding. He discussed our results with us, yet never forgot to whom the ultimate responsibility belonged, and talked over our plans for future

work; he was eager to find us tasks and material to treat as we liked, well knowing that scientific work has to be carried out in a free atmosphere in order to give the best results. All who had the privilege of working with H a r a l d B l e g v a d knew him as a really good man; he felt a true sympathy with his fellow men and willingly shared not only their joys but their griefs as well.

In the ranks of the International Council Harald B l e g v a d's death has caused a wide gap, a gap that will not soon close.

Erik M. Poulsen.



Helmuth Lissner.

1897—1951.

ON 15th February 1951, Dr. L i s s n e r, Director of the Sea Fisheries Research Station of the State of Israel, passed away. He had devoted his entire working life to the study of fishery problems, up to his very last days.

Dr. L i s s n e r was born in 1897, at Torun, Poland. He began his studies in his native town and finished his higher education at Leipzig University in 1922. There he submitted his doctorate thesis on the subject "Das Gehirn der Knochenfische". After getting his degree, he was appointed as assistant to Prof. E h r e n b a u m at the Marine Biological Institute in Hamburg. In that capacity, he was entrusted with the study

of the biology of the herring (*Clupea harengus* L.). The excellence of his work and the effort he applied to his task — he published about 40 papers and reports during this time — brought him an international reputation.

He published his first paper on the herring in 1925, and in 1929, 1930, and 1932, Dr. Lissner served as one of the official experts representing Germany at the meetings of the International Council for the Exploration of the Sea. Prof. Mielck, in his report to the 30th meeting of the Council, emphasized that much of the work carried out in Germany on *Clupea harengus* had been done by Dr. Lissner (Rapp. et Proc.-Verb., Vol. LXVI, p. 125, 1930).

With the advent of the Nazi regime in Germany, Dr. Lissner left the country to which he had devoted so much of his energy and ability, and began wandering from one fishery research centre to another.

He first came to England where he worked at Plymouth. There he published a paper on "The Races of Herrings" (Journ. du Cons., IX, 1934) which brought together and summed up his work in Germany on this subject. Thence he moved to Italy and started work at Rovigno d'Istria on the mackerel (*Scomber scomber*) and on a related species (*Scomber colias*) inhabiting the Adriatic Sea. He continued his work in Turkey with a study of mackerel of the Bosphorus (Internat. Rev. d. ges. Hydrobiol. 1937). After having spent the war years under Japanese rule in Manilla Dr. Lissner arrived in Palestine in autumn 1946, and joined the staff of the Sea Fisheries Research Station at Haifa. His wide experience of fishery research opened new fields to the young institution, and provided both teaching and practical encouragement to every member of the staff.

His personal acquaintance with leading scientists in the United Kingdom and Italy permitted him to build up for the institution an excellent scientific library in the difficult years following the World War.

Though he never enjoyed very robust health Lissner stuck stubbornly to the arduous work involved in fishery investigations and took part personally in almost every one of the experimental cruises undertaken by the station. During these years, while serving as Director of the Sea Fisheries Research Station, he drew the plans for modern trawls and published them in the local *Fishermen's Bulletin.*

After the recent war in Israel, although his illness was aggravated thereby, Dr. Lissner resumed his work on the

sardine and mackerel by investigating the fish of the Israel shores, including the "Tiberias Sardine".

Shortly before his death he was elected President of the Physical Oceanography Section of the local Geodesy and Geophysics Society.

During the last years of his life his two great ambitions were the setting up of a large fishing harbour near the ancient Roman town of Caesarea, and the provision of modern and well equipped laboratories for the Sea Fisheries Research Station. He lived to realize his desires, for it was not until three weeks after having formally opened the new building of the Sea Fisheries Research Station at Caesarea that Dr. L i s s n e r' s life came to an end.

O. H. Oren.

On the Role of the Ice off Iceland in the Decadal Air Temperatures of Iceland, and some other Areas.[1])

By

I. I. Schell,

Woods Hole Oceanographic Institution.[2])

A. Introduction.

Evidence from numerous investigations in the past two decades, or perhaps longer, points decisively to a marked rise in the temperature of the air over wide areas and to a smaller but no less significant rise in the temperature of the northern North Atlantic Ocean. Little, if anything, has been said about the possible causes of this rise and whether the relatively high temperatures may continue and for how long.

While a fully successful attack on this problem may not be possible until such time as we possess more adequate data, we can attempt to formulate the broad character of the problem for the North Atlantic and adjacent regions, for which a considerable body of data has recently been published, and to obtain indications of certain trends in the air and water circulation that could be checked with more comprehensive data as they become available.

The character of the ice off Iceland, which has been reliably observed for a long period and which over longer periods reflects in some measure both the changes in the limits of the Arctic ice mass and in the southward transport of polar water, permits in conjunction with the available long series of temperature data an analysis of a major phase in the fluctuations in the circulation of the northern North Atlantic and adjacent areas and, accordingly, will form the subject

1) Contribution No. 603 of the Woods Hole Oceanographic Institution.

2) This paper is published as a contribution to a research project on the relationships between polar ice and the weather, sponsored by the Office of Naval Research.

of the present investigation. As the problem before us in a deeper sense involves the problem of the origin of the variations in the general circulation, a discussion of the latter will be given first.

B. Origin of Variations in the General Circulation.

1. The Sun.

Admittedly, barring the possible influences of volcanic irruptions and other rare and singular occurrences in nature, the basic cause of all observed changes in the general circulation, and in the climate and weather, is the variations in the sun's radiation.

The hydrosphere, however, because of its large heat capacity and its slow rate of absorption and giving off its heat, budgets the heat it initially derives from the sun, to a considerable extent independently. In a much smaller measure this is also true of the atmosphere and instead of a single major source of energy affecting the general circulation — the sun — we have as indirect sources also the hydrosphere and atmosphere.

While we may expect a fall in the pressure in low and a rise in high latitudes following, it may be assumed, a poleward outflow of air from the equator during periods of high sunspot activity, should the atmosphere and hydrosphere call for trends in pressure opposite to that called for by the sun, the normal relation of pressure with increase in the sun's radiation could not be expected to emerge.

Thus, following a rise in the sun's radiation we may have either (a) the required trend in the circulation strongly developed if the trends called for by the hydrosphere and atmosphere are in phase with that of the sun, (b) the same trend moderately developed if the latter two media are in the neutral state, and (c) the trend poorly developed or entirely absent if the hydrosphere and atmosphere exert an influence in the direction opposite to that exerted by the sun, unless the rise in the sun's radiation is strong enough to overcome these influences.

The above, it is suggested, explains why comparisons of the sunspot number with the pressure, for example, have yielded results that differ substantially with a particular maximum or minimum sunspot period (as the general circulation is in or out of phase with that called for by the sun's variations) and why the division of the sunspot periods into major and minor maxima (among others, Hanzlik, 1930; Clayton, 1934; Willett, 1949a; Wexler[1]), 1950) and the

[1]) This author obtained significantly different results for the summer and winter seasons, and his results, furthermore, did not agree too well with Clayton's for an identical period (1910—20).

However, while an increase in the sun's radiation may be expected to produce equal pressure falls in winter and summer in equatorial latitudes, the called-for poleward flow of air in the northern hemisphere would be aided by the normal transport from the southern to the northern hemisphere in winter but impeded by the oppositely directed flow in summer. Thus the consistently greater effect found by Wexler (loc. cit) in winter than in summer for the average sunspot maximum as compared with the average sunspot minimum (see his Fig. 7, not reproduced here) was

further differentiation made from a consideration of the degree of sustained high and low sunspot activity (S c h e l l, 1943) produced results that were, in general, more consistent with the relationship expected than with undifferentiated periods of high and low sunspot activity. Yet while these and other studies have given support to the thesis that with high sunspot activity, etc., the pressure is on the whole lower in equatorial and higher in high latitudes than with low sunspot activity, etc., since the actual pressure patterns associated with the individual periods of high and low sunspot activity, etc., differ very markedly from each other, the quasi-independent control exercised by the hydrosphere and atmosphere on the general circulation appears, in general, considerably greater than the direct control exercised by the sun. It may be concluded that the analysis of the relationships within and between the hydrosphere and the atmosphere is a primary condition for elucidating the relationships between the sun's variations and the contemporary and following changes in the general circulation. The difficulty, it may be added, is not the "smallness" of the observed changes in the sun's radiation as it is sometimes assumed. Actually, we do not know the magnitude of change required in the sun to produce the observed large changes in the higher and small changes in the areally much greater lower latitudes. Again the "small" changes of the sun's radiation measured at the surface of the earth do not generally represent too well the actual changes in the sun's radiation. We know from the very significant correlations of sunspot activity with magnetic and auroral phenomena, for example, that the sun undergoes marked changes consistent at least with the monthly, seasonal, and longer-period sunspot numbers.

2. Hydrosphere and Atmosphere.

Having found it necessary to conclude that the origin of the circulation changes discussed here, appears intimately bound up with the preceding variations in the hydrosphere and atmosphere, we can now consider the possible approaches to derive the circulation interconnexions in question.

We have our choice, on the one hand, of a rigid mathematical treatment which in order not to overcomplicate the mathematics, involves an idealized state of the atmosphere, and on the other, a treatment determined from rough physical hypotheses or circulation indices whose validity depends on their withstanding the test of large accumulations of non-arbitrarily selected data. As the latter approach more closely deals with the actual conditions in the atmosphere than the former, it will be used here.

An index of circulation used not infrequently in recent years is the circumferential pressure difference between latitudes 35°N. and 55°N.,

to be expected. Also, the lack of a better agreement between W e x l e r's and C l a y t o n's findings — actually both found the expected higher pressure in the high latitudes — appears due to the different treatment and significantly different collections of data used by the two authors.

freely referred to as the "zonal index". For variations in the circulation extending over longer periods, this index may indeed be reasonably assumed to reflect an expanding or contracting polar anticyclone and the major changes in the climate and weather in the higher latitudes at least as suggested by Willett (1949b).

It does not appear, however, that for intervals of only a day, week, month, season, and perhaps longer, this circumlatitudinal pressure difference necessarily reflects a uniformly expanding or contracting circumpolar vortex and a true zonal circulation.

From the fact that when the North Atlantic air circulation (North Atlantic Oscillation) is more intense than usual, the North Pacific Oscillation is as frequently in as out of phase with the former (Walker and Bliss, 1932) and similarly, that when the Siberian High is better developed than usual this is not necessarily the case with the North American High, it may be concluded that circumlatitudinal pressure differences quite often represent deeply conflicting tendencies in the zonal circulation and cannot therefore be expected to yield any extensive correlation with the weather. This conclusion is supported by a number of studies (Willett, 1949a and others) which indicate little correlation on the whole of circumlatitudinal pressure differences with various synoptic or statistical systems. The fact that the results obtained were mostly negative suggests the desirability in general of treating the general circulation as a system of natural, more or less independent components of the whole, rather than treating conditions over an entire belt of latitude as a single unit. It is essential, however, that the treatment proposed should involve a physical principle that will permit broad and consistent application of the results obtained to the actual weather. In the following a principle that leads to physically based space-time-lag interrelations in the circulation will be stated more fully (see Schell, 1947).

C. The Principle of Dynamic Persistence.

Dynamic Persistence is a principle that covers relationships of the weather in certain areas that are synoptically linked to conditions in distant areas which have marked simple or local persistence. Dynamic Persistence thus introduces a physical linkage of space-time-lag variations in the circulation and operates as follows.

Given an area B whose weather during a given season is synoptically linked to another area A and, further, conditions in area A are markedly similar to those the season before (local persistence), the weather in the first-named area, B, must, it follows, be related to conditions in area A, also the season before. For example, if it can be shown that the pressure in an area A has (1) marked persistence from, say, the September—November to the December—February quarter and that (2) the December—February pressure and by association, also the storminess and precipitation in this area is synoptically linked to the pressure, storminess, and precipitation in area B the same season, it must follow

that conditions in area B during December—February are related to the pressure in area A also the quarter before, i.e., September—November.

Thus area A, in addition to exhibiting the property of local or simple persistence, may be said to possess also the property of influencing in September—November the precipitation, etc., in area B the following quarter through (1) persistence in pressure from September—November to December—February and (2) movement of storms from area A to area B during December—February. The term Dynamic Persistence, in the sense of an effect of local persistence being translated to the weather of another area, is used to define this property. The time difference involved in Dynamic Persistence makes possible in theory also the foreshadowing of conditions in area B from those in area A, before.

Of the several Dynamic Persistence relationships identified thus far (S c h e l l, 1947), the relationship of September—November tropical Australasia pressure (Manila, Port Darwin, etc.) to the following December—February quarter rainfall in the Philippines, south-east China, southern Japan, Midway, Wake, Hawaii, Aleutians, south-west Canada and north-west U. S. A., as well as south-east U. S. A. — through the inverse association between the storms in the north-west and those in the Gulf of Mexico — is the more remarkable. This large group of synoptically linked space-time-lag interconnexions arises from (a) the persistence in tropical Australasia pressure from September—November to the following December—February, (b) the relation of pressure to storminess in that general area, and (c) the movement of the storms across the North Pacific to North America.

The several Dynamic Persistence relationships outlined thus far are but a few of this class that may be presumed to exist in the general circulation. It also follows from the interrelation of different circulation systems that for areas with no Dynamic Persistence, relationships of a derivative nature may be expected. Thus, referring to the relationship with tropical Australasia pressure above, when the winter precipitation is above normal in the north-west and below normal in the south-east U. S. A. following below-normal pressure (increased storminess) in tropical Australasia the precipitation in the areas in between north-west and south-east U. S. A. is close to the normal.

In weighing the possible usefulness of Dynamic Persistence, as a basis for physically conceived space-time-lag relationships, we might have wished first to turn to the hydrosphere. Marked persistence is generally more characteristic of the oceans than the atmosphere, and we may, therefore, expect a large array of space-time-lag relationships within the oceans and because of the oceans' interaction with the air, also with the following climate and weather. A prime requisite for the examination of a rough physical theory is, we must insist, the use of long series of non-arbitrarily selected data. Consequently the oceans unfortunately cannot generally figure very prominently in this respect today. A notable exception are the variations in the sea ice from the

North Atlantic—Arctic, the record of which in the case of the waters off Iceland extends in some detail to the end of the 18th century and in a more general form, considerably earlier (K o c h, 1945).

D. Role of Polar Ice in the Circulation.

1. General Remarks.

The suggestion that polar ice plays an important role in the weather dates back considerably but it was not till later that an attempt was made by W i e s e (1924) and others to develop this idea into an inclusive hypothesis which they sought to verify with the rather sparse and short series of data available at the time.

Briefly, an increase in the ice in the Arctic and simultaneously in the Antarctic[1]) is assumed to occur when the general circulation weakens and less warm, moist air is transported to the polar latitudes. This causes a greater cooling and bigger ice formation there. Conversely, a decrease in the ice occurs with an intensified circulation and an increased transport of warm moist air to polar latitudes.

W i e s e (loc. cit.) further postulated that as a result of the marked persistence in hydrological processes due to the greater stability in the movements of large water masses and the large heat capacity of water, we may expect also relationships between the ice and the following circulation, etc., in the immediate area of the ice, and because of interaction of the circulation of higher with that in lower latitudes, also with the following weather in "adjacent" areas. Thus as the ice is presumed to be determined initially by the change in the general circulation, relationships may be expected between the ice and the preceding, following, and contemporary circulations, etc., in the immediate and adjacent areas.

In so far as relationships of the ice with the following circulation are concerned, it is not suggested that these are due to the melting of the ice, although this influence appears not negligible (S m i t h, 1931); nor is it suggested that the variations in the ice together with the much greater variations in the volume of polar water which the ice over longer time-intervals must reflect, could alone account for the observed changes in the circulation. Rather, severe ice conditions, for example, in the North Atlantic—Arctic together with the large increases in the volume of cold water flowing from the Arctic appear to mean an intrusion of considerable masses of polar water to the south[2]) and hence, a southward displacement of the zone of convergence of the cold

[1]) The verification of this is one of the principal aims of the current British-Norwegian-Swedish Antarctic Expedition.

[2]) No data are available for the variations in the southward transport of polar water, which, according to Z u b o v's (1945) estimates for the East Greenland Polar Current between Spitsbergen and Greenland (at 81°N.), amounted to 80,000 km^3. in 1937. It may be assumed from the fact that there was little or no ice off Iceland from 1919 to 1940 that the volume of polar water reaching Iceland, etc., during that period was very much less than in the period from 1865 to 1874, when Iceland was almost completely surrounded by ice for months at a time.

polar and North Atlantic warm water that is related also to the North Atlantic mean storm track, precipitation, etc. (Wiese, loc. cit., Brooks and Quennel (1928), Scherhag (1937), Schell (1940, 1947)).

The effects of the marked variations in the limits of the Arctic ice mass as well as in the southward transport of polar water, etc., may be secondary but nevertheless sufficient, especially following prolonged periods of either severe and light ice and a greater or smaller influx of polar water, to weaken or intensify existing trends in the circulation. As a result, warm periods, for example, may become relatively cooler than might be expected were it not for severe ice conditions prevailing, or warmer if little or no ice is present.

2. Ice off Iceland.

The relationship of the mean April—August ice area of the Greenland Sea to the following October—December precipitation in northwestern Europe through a latitudinal shift of the North Atlantic storm track, etc., (Schell, 1947) may be considered as but one of a broad group of Dynamic Persistence relationships involving the ice of the Arctic. Relationships involving variations extending over periods longer than a few months may also be assumed. As the aim of the present investigation was in part to formulate the problem of longer-period variations in the circulation, etc., of the northern North Atlantic and adjacent areas, only the latter type of variations in the ice, etc., will be dealt with here.

The longest records of Arctic ice are from off Iceland rather than from the Greenland Sea as a whole, which go back to 1877 only. Consequently, the Iceland observations will be used. The data will be compared first with the long records of temperature from Iceland, northern Europe, and New Haven, Conn. (U. S. A.). Later an attempt could be made to integrate into the comparison with the ice also the shorter records of storms, precipitation, etc. The comparison of the ice with the temperatures will, in keeping with our interest in the general role of polar ice in the circulation, etc., include also the temperatures preceding the longer-period variations in the ice.

E. Method of Analysis.

The ice and temperature data have been averaged by decades. Obviously, some periods of shorter duration of severe ice will be combined with some of light ice and, hence, certain relationships may be obscured. Broad trends, however, may be detected and later on attempts can be made to delineate still other trends.

The use of annual mean temperatures rather than temperatures for the ice season alone may be criticized. Nevertheless, there is considerable justification for this procedure, when one considers the persistence of given water conditions for longer periods than indicated by the presence of ice. Thus, although the ice season off Iceland lasts only

for a period of several months (i.e., from late winter or early spring to late spring or early summer), the flow of cold polar water, which likewise affects air temperatures, does not necessarily commence with the appearance of the ice or cease with its disappearance. Hence, in the absence of more information on the fluctuations in volume of the various water masses, it is actually impossible to determine the precise effect of the ice conditions alone.

F. Data.

Because significant temperature data (see below) for one of the more important areas are not available prior to 1831, the present study is based on data accumulated since that time. Thus, detailed data for 11 decades (1831—1940) and approximate information for one other (1941—50) are considered here. The last decade will be treated separately (see below).

1. Ice.

It is generally agreed that the ice observations off Iceland were carefully made and that they give a fairly accurate idea of actual ice conditions because of its importance in the lives of the inhabitants there. The severity of the ice season off Iceland is usually recorded as the number of days or weeks the ice was observed off the coast and by its relative abundance. This has been tabulated by Meinardus (1906) and more recently by Koch (loc. cit.) from observations of Thoroddsen (1884) and from records in „Isforholdene i de Arktiske Have", published by the Danish Meteorological Institute. Koch also included the extent of the ice surrounding the island. In general, the longer the ice is observed off Kap Horn on the north-west coast, the heavier it is and the farther it spreads eastward along the north coast, thence southward along the east coast and westward along the south coast.

For discussion of the causes of the ice situation off Iceland, the reader is referred to the literature. It should be noted, however, that prolonged periods of severe ice conditions off Iceland, such as those considered here, can, it is believed, occur only when the Arctic ice pack is well developed and a large quantity of ice is carried via the East Greenland and the East Icelandic Polar Currents to the vicinity of Iceland.

The Icelandic ice data presented here (Table I) consist of annual estimates taken from Koch's graph (1945, Fig. 103). These figures over a period of years show the number of weeks with ice multiplied by the number of areas where the ice was observed along the Icelandic shores. The mean annual values are given for each decade from 1831 in Table II. A comparison of the latter with those of Meinardus (loc. cit.) up to 1900 are remarkably alike except for those of the first decade (1831—1840). According to Meinardus this period was one of moderate ice, but according to Koch's analysis of Thoroddsen's data, it was a severe one. The latter, I believe, is more accurate

le I. Estimates of Annual Ice Severity off Iceland given by the Number Weeks multiplied by the Number of Areas with Ice around Iceland Each Year during 1831—1940 (after Lauge Koch, 1945).

r	Ice Severity	Year	Ice Severity	Year	Ice Severity	Year	Ice Severity	Year	Ice Severity	Year	Ice Severity
1	5	1851	0	1871	10	1891	49	1911	94	1931	0
2	1	2	0	2	20	2	131	2	0	2	6
3	0	3	6	3	7	3	0	3	0	3	0
4	24	4	6	4	94	4	0	4	26	4	0
5	207	5	95	5	0	5	38	5	47	5	0
6	0	6	15	6	60	6	83	6	2	6	0
7	137	7	36	7	2	7	3	7	3	7	0
8	4	8	35	8	60	8	3	8	34	8	12
9	5	9	96	9	3	9	2	9	1	9	0
40	184	1860	64	1880	9	1900	0	1920	0	1940	0
1	0	1	0	1	160	1	2	1	2		
2	0	2	6	2	113	2	138	2	0		
3	2	3	32	3	15	3	9	3	1		
4	0	4	0	4	0	4	0	4	1		
5	0	5	17	5	6	5	2	5	0		
6	0	6	174	6	60	6	3	6	0		
7	0	7	96	7	89	7	15	7	0		
8	3	8	40	8	251	8	2	8	1		
9	0	9	125	9	0	9	0	9	7		
50	4	1870	107	1890	0	1910	0	1930	0		

because he included the extent of the ice surrounding the island. Accordingly, in this report, that decade (1831—1840) is considered to have been one of severe ice.

Fortunately, the series just described contain three decades (1841—1850, 1921—1930, 1931—1940) which are characterized by little or no ice and three others (1831—1840, 1861—1870, 1881—1890) in which severe ice conditions (Table II) prevailed. In addition to these there is also a decade with light ice (1841—1850) following one of

Table II. Estimated Mean Annual Ice Severity off Iceland by Decade shown by the Number of Weeks with Ice multiplied by the Number of Areas with Ice around Iceland: 1831—1940 (after Lauge Koch, 1945).

Decade	Ice Units*	Type	Decade	Ice Units*	Type
1831—40	*56·7*	*Severe*	1901—10	17·1	Moderate
—50	*0·9*	*Light*	—20	20·7	Moderate
—60	35·3	Moderate	—30	*1·2*	*Light*
—70	*59·7*	*Severe*	—40	*1·8*	*Light*
—80	26·5	Moderate			
—90	*69·4*	*Severe*			
—00	30·9	Moderate	Average	29·1	

* See Table I.

severe ice and two successive decades with light ice conditions (1921—1930, 1931—1940). Thus the data afford a wide range of ice conditions for analysis.

2. Temperature.

Annual temperature records for various localities in the Arctic or sub-Arctic are available as far back as 1846 in Iceland (Stykkisholm), as 1840 in Norway (Vardø[1])) and as 1831 for Archangel[2]). Uninterrupted temperature series from other stations in northern Europe (north of 55°N.) go back even further (i.e., Stockholm, to 1757; Edinburgh, to 1764; Copenhagen, to 1798; Leningrad, to 1806). In North America, on the other hand, New Haven, Connecticut (41°18′N.) is the most northern station with a record extending as far back as 1780.

3. Localities considered for Study.

Since any long-period variations which show a correlation between ice off Iceland and temperatures in that and adjacent areas should be more obvious at stations within or near the Arctic, the situation is first examined at Stykkisholm (Iceland) and then compared with the record from Archangel followed by that for Vardø (Norway) and other localities in northern Europe and the United States.

The location of Archangel on the White Sea suggests that the temperature there is perhaps correlated with ice conditions in the Barents Sea. Unfortunately, ice data for the Barents Sea are not available prior to 1895. We may assume, however, that the mean decadal character of the ice off Iceland (Table II) is indicative in general of ice conditions for the same periods in the Barents Sea[3]). The long period changes appear similar in the two areas. Thus, the ice retreated northward in the 20's and 30's from both Iceland and the Barents Sea (as well as from the intervening area). Hence, comparison of the Archangel temperature with ice conditions off Iceland appears permissible.

At Vardø on the north coast of Norway, one might expect to find a relation between the temperature there and ice off Iceland similar to that at Archangel. On the other hand, although it is farther north than either Archangel or Stykkisholm, Vardø appears not as affected

[1]) Because there appears to be some doubt as to whether the earliest observations from Vardø (see below) are representative, the data for this station prior to 1868 should be treated with reservation.

[2]) After the completion of this report it was discovered that the temperature record at Archangel actually started in 1814 rather than in 1831, as listed in the Köppen-Geiger Handbuch der Klimatologie (1939). However, since the ice severity for the decade 1821—1830 was not extreme and since extreme ice conditions will be mainly dealt with here, the earlier temperatures have not been analysed in this report.

[3]) Beginning with 1895 the general ice pattern in the Barents Sea was generally severe until 1918. From then on to 1939 (last consecutive year available) it was light, or much the same as ice conditions off Iceland for the same periods. During the severe ice period (1895—1918) the mean annual temperature at Archangel and Stykkisholm were, respectively, 0·15°C. and 4·02°C. as compared with 1·53°C. and 4·92°C. respectively during the light ice period (1919—1939) which would corroborate the interdependence of the two areas for longer-period variations in ice.

by northerly winds as the other two (S h a w, 1936). Consequently, it might also be expected to show a somewhat different relation to the ice off Iceland and in the Barents Sea.

The relationship between the general character of the ice off Iceland and the mean decadal temperature at Stykkisholm, Archangel, and to a lesser extent Vardø, is, it was noted above, part of a more extensive system involving the circulation of the North Atlantic as a whole, the areas which border it, and possibly other regions as well.

Because there are no long series of data from the ocean areas in question, in order to show a relation between ice in the North Atlantic—Arctic and the circulation of that general area, it is necessary to use the comparatively long temperature records for areas bordering on the North Atlantic (i.e., northern Europe and the north-eastern part of the United States). The temperatures of these areas are noticeably influenced by the continental air masses. Nevertheless, if one could find a correlation between ice conditions off Iceland and temperatures at these localities, it would support earlier, more limited evidence that variations in the ice of the North Atlantic—Arctic are related to changes in the circulation over very large areas rather than over local ones.

G. Ice Conditions and Temperatures, 1831—1940.

Ice conditions (a) existing at the same decade, (b) in the preceding decade, or (c) in the subsequent one have been compared with air temperatures in the analysis of data (Tables III and IV) for the several localities under consideration here.

1. Stykkisholm.

(a) **Comparison with ice conditions in the same period.** For each of three decades with light ice (1841—1850, 1921—1930, 1931—1940), the mean annual temperature at Stykkisholm for the same period was above average (0·43°C.[1]), 0·65°C., 1·09°C., respectively), the highest positive deviation occurring for the decade 1931—1940 (Table III). On the contrary, for two decades with severe ice (1861—1870, 1881—1890), negative temperature deviations (—0·58°C., —0·53°C.) prevailed at Stykkisholm. These are likewise the lowest on record.

(b) **Comparison with ice conditions of the previous decade.** The decades (1871—1880, 1891—1900) with temperature deviations (—0·13°C., —0·12°C.) somewhat below average, follow decades (1861—70, 1881—90) with severe ice but a third (1841—1850) had a temperature deviation (0·43°C.) above average following a decade (1831—40) with severe ice. However, the latter (1841—50) was a period with little ice. It is significant that though the temperature deviation for the decade as

[1]) Based on 1846—1850 only. However, the entire period of light ice from 1841 to 1854 was implied by T h o r o d d s e n (M e i n a r d u s, 1906, p. 155) to have been rather mild in Iceland. According to evidence cited by J e n s e n (1939) the 1840's must have been quite mild also off the south-west coast of Greenland.

a whole was in all probability positive, it is equally probable that it was markedly less than for other decades with light ice (1921—30, 1931—40) which followed periods of moderate or light ice (Table III). Thus, the latter (1931—1940), following a decade with light ice conditions, had the largest positive temperature deviation (1·09°C.). The decade (1851—1860), on the other hand, which also followed one with light ice, had a small negative temperature deviation (—0·22°C.). This on closer examination appears to have been due to two extremely cold years (1859 and 1860). Thus, for the first eight years (1851—1858) the mean temperature deviation is slightly positive (0·11°C.).

Table III. Mean Annual Temperature Deviation from Long-Term Average at Stykkisholm, Vardø, and Archangel and the Severity of Ice off Iceland, by Decade, during 1831—1940.

Decade	Ice Severity (see Table II)	Stykkisholm °C. Δ	Archangel °C. Δ	Vardø °C. Δ
1831—40	*Severe*	—	— ·47†	—
—50	*Light*	·43*	·35	(— ·20)
—60	Moderate	— ·22	·18	(— ·16)
—70	*Severe*	— ·58	— ·36	(— ·42)
—80	Moderate	— ·13	— ·71	— ·25
—90	*Severe*	— ·53	— ·30	— ·17
—1900	Moderate	— ·12	— ·68	— ·29
—10	Moderate	— ·12	·01	— ·03
—20	Moderate	— ·20	— ·11	·00
—30	*Light*	·65	·65	·53
—40	*Light*	1·09	1·41	·97

* 1846—50. ( ) Approximate value. † 1832 lacking.

(c) **Comparison with ice conditions in a subsequent decade.** Two decades (1861—70, 1881—90) with extreme negative deviations in temperature at Stykkisholm were each followed by moderate, not severe, ice conditions off Iceland (Table III). On the other hand, following decades with a marked positive temperature deviation (1841—50; 1921—30; 1931—40), the ice conditions were moderate in two decades (1851—60; 1941—50[1])) and light in the other (1931—40).

From the foregoing, it is obvious (1) that the decadal temperatures at Stykkisholm reflect ice conditions off Iceland for the same period. Furthermore, it appears (2) that after a decade of severe ice off Iceland, the next decade in the general area of Iceland has temperatures below the average unless it be one with little ice. Similarly, in a decade following one with light ice, the temperature is above average[2]).

(3) Finally, as might be expected, no relationship between the air

[1]) According to preliminary reports, see p. 29.

[2]) The character of the ice during 1941—1950 is available only in terms, "close to normal", "above" and "below". This and other considerations made it desirable to treat the results for this period separately. Hence, for the temperatures above average following the light-ice decade of 1931—1940, see p. 29.

temperatures of Iceland and ice conditions which occur there at a later date was found, because as mentioned above, the ice off Iceland is chiefly carried down from the north and is not of local origin.

2. Archangel.

(a) **Comparison with ice conditions in the same period.** The temperature deviations for Archangel are positive (0·35°C., 0·65°C., and 1·41°C.) for three decades (1841—50, 1921—30, 1931—40) with light ice. The highest temperature occurred in the third which followed a decade with light ice (Table III). As at Stykkisholm, on the other hand, the temperature at Archangel for the two decades (1861—70, 1881—90) with severe ice as well as for the first decade (1831—40) was below average, deviations being —0·47°C., —0·36°C. and —0·30°C. respectively. These deviations are, however, smaller than those at Stykkisholm. This is the more significant because the standard deviation, σ, of the mean annual temperature at Archangel, ±1·22°C. (1831—1940) is appreciably greater than at Stykkisholm ±0·94°C. (1846—1940).

(b) **Comparison with ice conditions of the previous decade.** Two decades (1871—80, 1891—1900) following decades (1861—70, 1881—90) of severe ice off Iceland, had temperatures (—0·71°C. and —0·68°C.) below average but a third (1841—50) which was free of ice, following one (1831—40) of severe ice had a small positive deviation (0·35°C.). The positive temperature deviation for this decade, however, is much less than those for two other decades with light ice (Table III). Hence, one may assume that had this period (1841—1850) not been almost entirely free of ice, the temperature would likewise have been below average. One decade (1851—1860), on the other hand, following one (1841—1850) of light ice had a slight positive temperature deviation (0·18°C.), but another (1931—1940[1])) had a greater one (1·41°C.), the largest such value recorded (Table III). This in part was probably due to the absence of ice during the period 1931—40.

(c) **Comparison with ice conditions in a subsequent decade.** The three coldest decades at Archangel (1831—40, 1871—80, 1891—1900) were followed by one (1841—50) of light ice, by one (1881—90) of severe ice and by one (1901—10) of moderate ice. Likewise, no consistent relation can be traced between decades with relatively high temperatures at Archangel and ice in subsequent periods off Iceland. Thus, two decades (1841—50, 1931—40[2])) were followed by moderate ice, and a third (1921—30) by light ice.

In short, ice conditions off Iceland are related to temperatures at Archangel for the same period or in the next decade in about the same way as at Stykkisholm, but there is no apparent relationship between temperatures there and ice conditions off Iceland in the next decade.

1) For a discussion of temperatures following the decade 1931—1940, see p. 29.
2) According to preliminary reports (p. 29).

3. Vardø.

(a) **Comparison with ice conditions in the same period.** The Vardø temperature deviations for decades of severe ice (1861—70, 1881—90) are — 0·42°C. and —0·17°C. respectively. Similarly, for three decades with light ice (1841—50, 1921—30, 1931—40), the deviations were —0·20°C., 0·53°C., 0·97°C. respectively (Table III). Thus, only the temperature of the decade (1841—50) does not reflect the ice conditions. Since some of the early Vardø observations are apparently approximations it appears that the Vardø values are relatively consistent with the ice for the general area off Iceland and presumably the Barents Sea.

(b) **Comparison with ice conditions of the previous decade.** Omitting the early Vardø observations, the temperature deviations for the decades (1871—80 and 1891—1900) are both negative (—0·25°C. and —0·29°C. respectively). Both periods followed decades of severe ice. On the contrary, the deviation in the decade (1931—40[1])) which followed a light-ice decade, was positive (0·97°C.). The large deviation in all probability was due to light ice conditions during that period[1]).

(c) **Comparison with ice conditions in a subsequent decade.** Following the two decades (1861—70 and 1891—1900) with the lowest temperatures at Vardø, ice was moderate. On the contrary, following the two with the highest temperatures (1921—30, 1931—40), the ice was light in one (1931—40) and moderate in the other (1941—50[2])).

From the above it appears that the temperatures at Vardø as at Archangel show no consistent relationships to the ice conditions off Iceland the next decade, as was to be expected.

4. Northern Europe (exclusive of Archangel and Vardö) and North-Eastern United States (New Haven, Connecticut).

(a) **Comparison with ice conditions in the same period.** Three decades of severe ice were accompanied by negative temperature deviations in northern Europe as a whole exclusive of Vardø and Archangel, but only the first two (1831—40, 1861—70) had values markedly below the average (—0·41°C. and —0·42°C. respectively) (Table IV). In contrast, two of the three decades (1921—30, 1931—40) of light ice had temperatures above average. For the latter the positive deviation was very marked (0·98°C.).

At New Haven, Connecticut, the temperature deviations (Table IV) were appreciably below the average (—0·83°C., —0·33°C. and —0·41°C. respectively) during each of three decades with severe ice (1831—40, 1861—70, 1881—90) and markedly above the average (0·59°C., 1·18°C.) during two light-ice decades (1921—30, 1931—40) but not during a third (1841—50) (—0·04°C.).

(b) **Comparison with ice conditions in the previous decade.** The temperature deviation of northern Europe following two decades (1831—40, 1861—70) of severe ice were both negative (—0·25°C., —0·35°C.)

[1]) For the positive temperature deviation following the light-ice decade (1931—1940), see p. 29.

[2]) According to preliminary accounts (p. 29).

Table IV. Mean Annual Temperature Deviation from Long-Term Average in Northern Europe (exclusive of Archangel and Vardø) and North-Eastern U.S.A. by Decade and the Severity of Ice off Iceland during 1831—1940.

Decade	Ice Severity †	Bergen °C. Δ	Edinburgh °C. Δ	Oslo °C. Δ	Stockholm °C. Δ	Copenhagen °C. Δ	Helsinki °C. Δ	Leningrad °C. Δ	Moscow °C. Δ	Northern European °C. Δ	North-eastern U.S.A. (New Haven, Conn.) °C. Δ
1831—40	S	—·05	—·27	—·51	—·43	—·53	—·31	—·84	—·35	—·41	—·83
—50	L	—·02	·01	—·60	—·25	—·39	—·29	—·24	—·20	—·25	—·04
—60	M	—·02	—·02	—·36	·11	—·28	—·25	—·02	—·15*	—·12	—·48
—70	S	—·16	—·17	—·38	—·57	—·33	—·64	—·47	—·66	—·42	—·33
—80	M	—·19	—·28	—·29	—·42	—·25	—·42	—·53	—·41	—·35	·35
—90	S	—·14	—·26	·00	—·12	—·19	—·02	·07	—·05	—·09	—·41
—00	M	—·15	·23	·19	·23	·18	—·05	—·11	—·13	0·5	—·06
1901—10	M	—·01	—·07	·30	·02	·06	·19	·24	·21	·12	—·05
—20	M	·00	·09	·41	·22	·40	·26	·29	·19	·23	·38
—30	L	·09	·10	·20	·16	·28	·34	·33	·38	·24	·59
—40	L	·65	·59	1·09	1·03	·93	1·24	1·14	1·17	·98	·86

† S = Severe, M = Moderate, L = Light. * Based on 9 years only.

but it was somewhat positive (0·05°C.) during a decade (1891—1900) after one (1881—90) of severe ice (Table IV). Following one decade (1841—50) of light ice there was one with a negative temperature deviation (—0·12°C.) but another (1921—30) was followed by one with a positive temperature deviation (0·98°C.[1])).

Likewise, no consistent relation appears between the temperature of New Haven and the ice of the period preceding it. Thus, for the decades (1841—50, 1891—1900) which followed decades of severe ice, the temperature deviations (Table IV) were negative (—0·04°C. and —0·06°C. respectively), but for a third (1871—80), it was positive (0·35°C.). Similarly, one decade (1841—50) of light ice was followed by a negative deviation (—0·48°C.) at New Haven, but a second (1921—30) by a positive deviation (0·86°C.).

(c) **Comparison with ice conditions in a subsequent decade.** For northern Europe, a cold decade (1831—40) was followed by light ice off Iceland, a second (1861—70) by moderate ice there, and a third somewhat less cold decade (1871—80) by severe ice (Table IV). Similarly, at New Haven, Connecticut, a cold decade (1831—40) was followed by light ice, a second (1851—60) by severe ice, and a third (1881—90), which was somewhat less cold, by moderate ice. Again, the warmest decade (1931—40) of all, both in northern Europe and at New Haven, is apparently followed by one with moderate ice (p. 29).

From the comparisons presented above, it appears that temperatures

[1]) For the positive temperature deviations following the light-ice decade (1931—1940) see p. 29.

along the north-western and north-eastern borders of the North Atlantic are to some extent related to variations in the ice conditions occurring at the same time off Iceland. One might also expect an ice-temperature correlation between a given temperature trend and ice conditions at some subsequent time, because of the time which must elapse before changes in the circulation of the North Atlantic produce any obvious effects on ice conditions to the north. However, this does not appear to be true since the mean temperature for one decade in northern Europe and the north-eastern United States appears to have no consistent relationship with the ice of the next. This was actually to be anticipated because the temperature variations of these land masses are markedly determined by the air masses over these continents, especially in winter with the development of the Sibirian and North American Highs, rather than by the waters off their shores.

The absence of a consistent relation for northern Europe, other than at Archangel and Vardø, between decadal ice conditions off Iceland and the mean decadal temperatures in the next decade does not imply that such a relationship does not exist for shorter time intervals. Thus, following severe ice conditions between April and July in the Greenland Sea, the mean North Atlantic cyclonic track (Wiese, loc. cit.), the pressure distribution over north-western Europe (Brooks and Quennell, loc. cit.), and precipitation over the same area (Schell, 1947) in subsequent months all appear to vary with severe- and light-ice conditions.

H. Effect of Ice off Iceland on the Subsequent Temperature at Archangel.

From the examination of the mean decadal character of the ice and corresponding temperature deviations above, it appears that following severe ice, the temperature deviations at Stykkisholm and Archangel tend to be negative and following light ice, positive. With severe ice conditions, for example, off Iceland and a greater flow of water from the Arctic, more cold water can be expected to mix with the warm North Atlantic water moving north-eastward as the Norwegian Current to the Barents Sea and northward to Spitsbergen (Fig. 1[1])).

Farther south, either a southward displacement[2]) of the warm North Atlantic water mass (le Danois, 1934) or a contraction of the warm North Atlantic cell, presumably due to the strengthening of the trade wind circulation (Iselin, 1940), results in a southward displacement of the Arctic convergence zone and in a reduced flow of warm water from the south-west. Coincident with the decreased flow of warm water into the Arctic, less warm air would be transported north-eastward.

[1]) Information obtained since the publication of Nansen's paper confirms the basic picture drawn by him (Kiilerich, 1945).

[2]) The word "displacement" seems to the writer a better term for le Danois's "transgression" in describing the horizontal swayings of the large mass of warm North Atlantic water.

In addition, because some time must elapse before the effect of severe ice conditions off Iceland, a stronger East Icelandic Polar Current, etc., can be felt in the general Barents Sea area, the negative temperature deviation at Archangel which arises from the persistence effect of severe ice locally may be expected to be accentuated. Hence, following extreme ice conditions the temperature deviation at Archangel may be expected to be greater than at Stykkisholm where it depends on local persistence of such conditions only and also greater following than during these periods of extreme ice conditions.

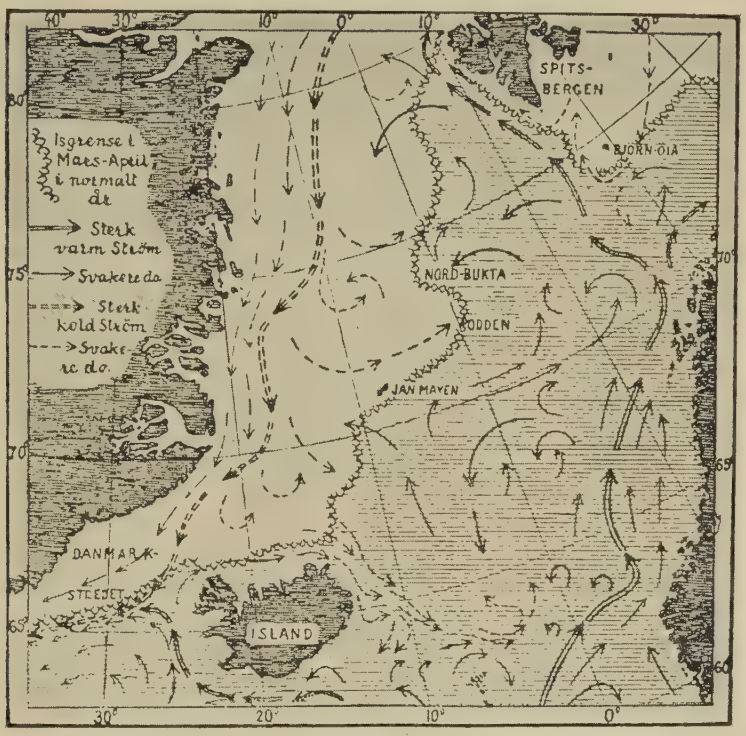


Fig. 1. Map showing currents and ice conditions in the North Atlantic. After Fridtjof Nansen 1924.

Thus, for the two decades (1871—80; 1891—1900) each following one with severe ice, the negative temperature deviation in each (Table V) was (1) greater at Archangel than at Stykkisholm (—0·58°C. v. —0·13°C. and —0·68°C. v. — 0·12°C. respectively) and (2) greater at Archangel in the succeeding decade than during the one (—0·58°C. v. —0·36°C. and —0·68°C. v. — 0·30°C., respectively) of the severe ice.

For a decade (1841—50) of light ice with a positive temperature deviation (smaller than during the other two light decades presumably in response to the decade of severe ice before (1831—40)), the positive deviation was smaller at Archangel than at Stykkisholm (0·35°C. v.

0·43°C.). This suggests that cold water and ice at Iceland the previous decade (1831—40) may have affected conditions at Archangel the succeeding one (1841—50).

The decade of moderate ice (1851—60) following another with light ice (1841—50) showed a positive temperature deviation at Archangel as compared with a negative one at Stykkisholm (0·18°C. v. —0·22°C.). The Archangel temperature, however, was not higher than that for the previous decade[1]). The temperature deviation at Archangel for 1931—40, following the light-ice decade (1921—30) was somewhat greater

Table V. Differences in Temperature Deviations between Archangel and Stykkisholm for Decades following Severe and Light Ice, respectively, off Iceland: 1831—1950.

Decade		Ice Character		Archangel °C. Δ	Stykkisholm °C. Δ	Difference °C. Δ
Contemporary	Following					
1831—40		Severe		— ·47	—	
	1841—50		Light	·35	·43	— ·08
1861—70		Severe		— ·36	— ·58	
	1871—80		Moderate	— ·58	— ·13	— ·45
1881—90		Severe		— ·30	— ·53	
	1891—00		Moderate	— ·68	— ·12	— 56
1841—50		Light		·35	·43	
	1851—60		Moderate	·18	— ·22	·40
1921—30		Light		·65	·65	
	1931—40		Light	1·41	1·09	·32
1931—40		Light		1·41	1·09	
	1941—50		Moderate	2·3*	1·14	

* 1949 only.

than at Stykkisholm even allowing for Archangel's larger standard deviation, σ, (1·41°C. v. 1·09°C.) and was also greater than for the previous decade (1·41°C. v. 0·65°C.). It is not possible to make any definite conclusions about the effect of light ice off Iceland for 1931—40 on the Archangel temperature in the years 1941—50, because only one year (1949) of the Archangel record is available. Furthermore, the decade (1931—40) itself was one of little ice. The Archangel deviation that year was positive and one of the largest (2·3°C.) on record.

On the whole, following severe and light ice respectively, off Iceland, the temperature at Archangel is more extreme than at Stykkisholm since it not only reflects conditions in that general area but also seems accentuated by a stronger or weaker East Icelandic Current diluting the warm North Atlantic water entering the Barents Sea. This

[1]) The circulation associated with the light-ice decade (1841—50) was probably not as intense as during the recent light-ice period (1919—1940) when all of northern Europe as well as north-eastern United States had the highest temperatures on record. This may explain the rather small positive temperature deviation at Archangel the next decade (1851—60) and negative deviation at Stykkisholm. (For the first eight years (1851—58) it was positive, averaging 0·11°C.).

is a Dynamic Persistence relationship. The temperature trend at Archangel is related to the preceding conditions in the general area off Iceland through the persistence of these conditions and a translation of their effect north-eastward.

I. Ice and Temperature Trends: 1941—1950 and after.

The light ice off Iceland during the last two decades (1921—40) raises the question as to whether the mean temperature during the present one (1941—50) in the general vicinity of Iceland, Vardø, and Archangel will prove to be above average and also as to whether the positive deviation at Archangel will be greater than at Stykkisholm as suggested above. Actually, since there were two consecutive decades with light ice we might expect to find especially large positive temperature deviations at Stykkisholm for 1941—50 provided the ice trend during this decade has not reversed itself.

Rough estimates of the ice conditions off Iceland for the period 1941—50 (U.S. Coast Guard Bull. 1947; Dansk Meteorologisk Institut; author's correspondence) indicate the following:—

1941	"close to normal"
1942	"below normal"
1943	"somewhat above normal"
1944	"much above normal"
1945	"close to normal"
1946	"close to normal"
1947	"somewhat less than normal"
1948	"close to normal"
1949	"much above normal"
1950	"somewhat less than normal"

or, taking the ten years together the ice off Iceland for 1941—50 may be considered as "close to normal".

Hence, since the ice as a whole was not severe enough to counteract a trend toward temperatures above normal influenced by the presence of little ice in the two preceding decades, we may assume that the mean temperature for 1941—50 was to be above average at Stykkisholm, at Archangel, and perhaps also at Vardø.

Observations at Stykkisholm indicate that the mean annual temperature for the period 1941—50 corresponding to on the whole normal ice conditions off Iceland was 1·14°C. above average compared with 1·09°C. in the preceding decade (1931—40). The mean annual temperature at Archangel for the year 1949 was one of the highest on record. At Vardø[1]) the average temperature deviation based on eight years (1941—3, 1946—50) was 0·47°C.[2]).

[1]) The station was destroyed in August 1944 and did not open again until June 1945. Comparison with neighbouring stations, however, indicated that the annual temperature in 1944 and 1945 was slightly above normal.

[2]) The mean 1941—50 annual temperature deviation at Edinburgh was 0·55°C., at Bergen 0·56°C., at Oslo 0·91°C., at Stockholm 0·74°C., at Helsinki 0.68°C., at Copenhagen 0·80°C., and at New Haven, Connecticut, 1·50°C. (Table VI).

Table VI. Average Annual Temperatures at Archangel, Bergen, Copenhagen, Edinburgh, Helsinki, Leningrad, Moscow, New Haven (Conn.), Oslo, Stockholm, Stykkisholm, and Vardø for the Period 1831—1940 and Decade 1941—50 (except as noted).

Year	Archangel	Bergen	Copenhagen	Edinburgh	Helsinki	Leningrad	Moscow	New Haven	Oslo	Stockholm	Stykkisholm	Vardø
	°C.	°C.	°C.	°F. 40 †	°C.	°C.	°C.	°F. 40 †	°C.	°C.	°C.	°C
1831—1940	0·41°	7·22	7·66	7·26	4·22	4·01	4·22†	9·37	5·72	5·78	4·15*	0·93°°
1941—1950	—	7·78	8·46	8·19	4·90	—	—	12·08	6·63	6·62	5·28	1·40**

° Except 1832. † Except 1859. * 1846—1940. °° 1841—1940. ** Mean 1941—43, 1946—50.

Comparing the ice off Iceland for the period (1941—50) with that of the preceding 22 years (Table I), it appears that while in the 10-year period (1941—50) the ice was on the whole "close to normal" and in at least two years, "above normal", in each year of the period 1919—40 the ice was "below normal". Fourteen years had no ice at all. The trend, therefore, for very little ice may not have reversed itself, but, at least, it has temporarily ceased.

If the general atmospheric circulation is self-contained, any prolonged rise in the temperature in high latitudes will weaken the general atmospheric south-north temperature gradient. As a result, the transport of warm air poleward will soon decrease and conditions favouring an increase in the polar ice-cap and a greater flow of ice into the East Greenland Polar Curent and also towards Iceland will occur once more (S c h e l l, 1940).

We may, therefore, expect from the relationship described above and from the evidence for the period 1941—50, suggesting that the trend of light ice has ceased, that everything else being constant, the trend toward high temperatures in the general vicinity of Iceland, Vardø, and Archangel is not likely to continue long in its present intensity. The change at Archangel, however, would be expected to occur later than at Stykkisholm.

J. Summary.

1. We have assumed that due to the interaction between air and the oceans the trend of ice off Iceland and that general vicinity must be closely related to the circulation in the northern North Atlantic and adjacent areas. In addition, because of local or simple persistence of the ice and the polar water associated with it, a relationship was also assumed between ice of the North Atlantic—Arctic and the circulation trends for the next decade in the area of the ice and general vicinity. Finally, because the effect of simple persistence in the ice etc. may be

also translated to distant areas with which the ice area is linked synoptically, a relationship was assumed between the ice etc. off Iceland and the following conditions to the north-east, in accordance with the general circulation pattern of that region.

2. In this investigation, only the air temperatures of Iceland, northern Europe, and the north-eastern United States (1831—1950) were compared with ice conditions off Iceland. A consideration of direct measures of air and water circulation to be derived from ocean currents, pressure distribution, winds, etc. is planned for the future. The analysis was also limited to prolonged periods of severe- and light-ice conditions to permit the relationships between ice and temperature to become more obvious than is possible in comparing "close to normal" conditions. Under the latter circumstances, fluctuations in the temperature can occur in either direction[1]) because of the quasi-stable character of the circulation.

3. Comparison of the mean decadal ice extremes with mean temperatures for the same decades at Stykkisholm, Archangel, and Vardø indicates a definite relationship between the two for the same period (Table III). Thus, three decades with severe ice off Iceland (1831—40, 1861—70, 1881—90) were accompanied by temperatures below average at Archangel. At Stykkisholm and Vardø, where no data are available for a decade with severe ice (1831—40), temperatures were below average in the other two decades in question. Similarly, three decades with light ice (1841—50, 1921—30, 1931—40) were accompanied by temperatures above average except at Vardø in the one decade (1841—50), (see below). Comparison of the mean decadal temperature of northern Europe, exclusive of Archangel and Vardø, and of the north-eastern United States with the ice off Iceland indicates that the circulation over these areas is to a marked degree part of the same process that determines ice conditions of Iceland (Table IV).

4. Furthermore, the temperatures of Iceland, Archangel, and perhaps also Vardø[2]) are seemingly related to the ice conditions of the previous decade. This apparently means that the effects of ice and cold water persist for a considerable period locally. Thus, lower than average temperatures usually follow decades with heavy ice, and higher

[1]) Actually, at Stykkisholm, which unlike Archangel, appears to be uncomplicated by an accentuation of effects caused by a transport of water from the west, the temperature deviation also corresponded to the ice character for the moderate ice decades.

[2]) From the fact that Vardø lies between Iceland and Archangel and appears more exposed to the influence of the warm North Atlantic water flowing around the North Cape than Archangel, we might have expected better agreement between the Vardø temperatures and the ice conditions of the previous decade than was actually obtained. We have already noted the possibility that some of the Vardø observations during the early period of that station's operation are only approximate. It is also possible in view of Vardø lying to the west of Archangel that the effect of different ice extremes off Iceland on Vardø's temperature occurs earlier there than at Archangel and for that reason the relation of the Vardø temperature with the ice may not have been as clear in the decadal comparison.

temperatures, decades with light ice. In addition, these are presumably strengthened at Archangel by cold water carried south-eastward from Iceland and mixed with the north-eastward flowing warm North Atlantic water on the principle of Dynamic Persistence. Hence, at Stykkisholm the extreme deviations occur during periods of extreme ice conditions (Table III), but at Archangel, the extreme deviations occur in the decade following one of extreme ice conditions.

5. No consistent relationship was indicated between the ice off Iceland and the temperature of Iceland, Archangel, Vardø, etc. during the preceding decade.

6. The reversal in trend from practically no ice at all during the period from 1919 to 1940 toward on the whole normal conditions for the period 1941—50 suggests that the trend toward comparatively high temperatures in the general areas of Iceland, Vardø, and Archangel is not likely to continue much longer. The change at Archangel would, however, occur later than at Stykkisholm.

7. The explanation of the decadal temperature trend at Iceland and Archangel in terms of the preceding circulation as reflected in the ice off Iceland rather than in terms of the sunspot number[1]) suggests that while solar changes may be the basic cause of the variations in the general circulation, they cannot be readily discerned in the temperature fluctuations examined here.

K. Appendix.

1. Influence of City Development on the Temperature.

In connexion with the increase of the temperature in recent decades at stations considered here, the question arises as to what extent the rise at stations in cities has been due to the growth of the city itself. A recent comparison (L i l j e q u i s t, 1943) of the mean December—March temperature in Stockholm and with a station "2·5 km. north of the observatory of Stockholm and about 1·5 km. outside Stockholm proper" for the period 1882—1940 shows that the observatory values have always been slightly higher, but there has been no consistent increase in the temperature difference between the two locations. Similarly a comparison of the annual temperatures in Copenhagen with those of a neighbouring village for the period 1861—1935 indicates that the effect of upbuilding is only about 0·15°C. (L y s g a a r d, 1937). Essentially the same conclusions have been drawn for other areas, such as the United States (K i n c e r, 1933, 1946), and the East Indies (d e B o e r and E u w e, 1949). From these reports we may safely conclude that by far the major portion of the marked rise in temperatures in recent decades at Oslo, Leningrad, Moscow, etc. was due to the same causes that produced the rise at Stykkisholm where the question of city upbuilding does not arise.

[1]) The average sunspot number for the 3 light-ice decades was 57, 42, and 54 respectively, and for the 3 severe-ice decades, 66, 53, and 35 respectively.

2. Temperature Data.

The data were taken for the most part from World Weather Records by H. H. Clayton (Editor) (1927, 1934, 1947) and the Handbuch der Klimatologie by W. Köppen and R. Geiger (1939). The use here of temperature observations over the long period 1831 to 1940 or later made it desirable to examine the data carefully to make sure that the data were comparable. In many cases the site of the stations had changed. Accordingly certain corrections have been necessary for some of the published series.

Archangel.

The mean annual values for 1831—1930 except for the years 1832, 1833, and 1921 are available in the Köppen-Geiger (1939) Handbuch d. Klimatologie (Section N_2) tabulated as deviations from the mean 0·2°C. The values for 1881—1915 were 0·1°C. too high, and from those for 1922—1930, 0·2°C. had to be subtracted, to correct them to the 24-hr. mean.

The data for 1921 were found in Réseau Mondial and an approximate value for 1833 was derived from the figures for the 10-month period March—December and the long-term average for January and February. The new mean derived from the 109-year series, 1831—1940 (less 1832), is 0·41°C. The mean annual value for 1949 was derived from figures in Die Mitteleurop. Grosswetterlage, Deutsch. Wetterdienst, U. S. Zone, Bad Kissingen.

Leningrad.

The values given as deviations from a mean of 3·9°C. for 1831 to 1920 were taken from the Köppen-Geiger (1939) Handbuch d. Klimatologie and those for 1921—1940 from World Weather Records (Clayton (Ed.), 1927, 1934, 1937). The annual values for 1921—30 were reduced by 0·1° to correct them to 24-hr. means. The 1831—1940 mean is 4.01°C.

Moscow.

The temperature values given as deviations from a mean of 3·5°C. at the Konstantin Institute (55°36′N., 37°40′E.) for 1831 to 1930 (except 1859) were taken from the Köppen-Geiger (1939) Handbuch. The values for 1916—1930 represent temperatures from another station, the Agricultural Institute (55°50′N., 37°33′E.), where the mean annual temperature was found to be 0·7°C. lower. Thus, the values from 1916 to 1930 had to be increased by 0·7°C. However, since those for 1921—1930 were not corrected to 24-hr. means, only 0·6°C. was added to the values for that period. Furthermore, the March 1930 temperature was incorrectly given as —12·2° instead of —1·2° (in both the Handbuch and the World Weather Records), the net rise for that year was actually only +1·5°C.

Finally, the values for 1931—40 (World Weather Records, Volume III) had to be increased by 0·7°C. to make them comparable with the corrected series for 1831—1930. The new mean derived from the 109-year series (1831—1940, omitting 1859) is 4·22°C.

Stykkisholm.

Mean annual temperatures for the period 1846—1930 were taken from World Weather Records (Clayton (Ed.), 1927, 1934, 1937) and for all subsequent years were obtained through correspondence. The values are based on observations made at 2 p. m. except for the period January 1869 to May 1873 when the observation was taken at noon. The latter have been adjusted to conform with the 2 p. m. reading by adding 0·4°C., with one exception (1873). For the five months of that year only 0·2°C. was added. The mean based on the 95-year period, 1846—1940, is 4·15°C.

Bergen and Oslo.

The mean annual temperatures up to 1940 were taken from World Weather Records (Clayton (Ed.), 1927, 1934, 1937), and for subsequent years, from official publications and by correspondence. The Oslo station was moved to a new site (Blindern) in May 1937, and the records taken there have been reduced to make them comparable with the series from the old site by adding 0·9°C. to the annual figure. The Bergen and Oslo means for the period 1831—1940 are 7·22°C. and 5·72°C. respectively.

Vardø.

The data for the period from 1867 to 1933 are from Table II (p. 33), those from 1840 to 1866 from Tables Ia and I b (p. 32) in Birkeland's (1934) paper, and those after 1933 from official publications and from personal correspondence. The figures for the period from 1867 to 1875 in Table Ib (Skancke's series) do not differ in a uniform way from those for the same period in Table II. Thus, some of the values for 1856 to 1866 as well as those for some of the earlier years must be regarded as approximations only. The mean value for the 100-year period 1841—1940 is 0·93°C.

Stockholm.

The data given as deviations from the mean 5·7°C. until 1925 were taken from the Köppen-Geiger (1939) Handbuch der Klimatologie and after that were obtained from official publications and by personal correspondence. The 1831—1940 mean is 5·78°C.

Copenhagen.

The information up to 1940 is from World Weather Records (Clayton (Ed.), 1927, 1934, 1937) and for subsequent years by correspondence. The 1831—1940 mean is 7·66°C.

Edinburgh.

The mean annual values from 1831 to 1863 are taken from a paper by Brunt (1925), from 1864 to 1940, from World Weather Records (Clayton (Ed.), 1927, 1934, 1937), and from 1941 on, through personal correspondence. Because of a recent change in the site of the station, 0·6°F. was added to the annual figure to make the values after 1930 comparable with the earlier series with 1931. The mean value for the 110-year period 1831—1940 is 47·26°F.

New Haven, Connecticut.

The data up to 1940 were obtained from World Weather Records (Clayton (Ed.), 1927, 1934, 1937) and subsequently through personal correspondence. After 30. June 1943, temperatures have been taken at the airport station. To reduce the data taken there to a comparable basis with that of the old site, 1·9°F. has been added. For 1943, however, to adjust for the first six months at the old site, only 1·0°F. was added. The mean value for the 110-year period of 1831—1940 is 49·37°F. The value for the year 1897 was erroneously given as 48·7°F. instead of 49·5°F.

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M. References.

Birkeland, B. J. (1934). "Ältere Meteorologische Beobachtungen in Vardø." Geof. Publik., **10**, 9, pp. 1—52.

Brooks, C. E. P., and W. A. Quennell (1928). "The Influence of Arctic Ice on the Subsequent Distribution of Pressure over the Eastern North Atlantic and Western Europe." Met. Off. Geophys. Mem., 41, pp. 1—36.

Brunt, D. (1925). "Periodicities in European Weather." Phil. Trans. Roy. Soc., A 225, pp. 247—302.

Clayton, H. H. (Editor) (1927, 1934, 1947). "World Weather Records." Smiths. Misc. Coll., **79**, **90**, **105**.

Clayton, H. H. (1934). "World Weather and Solar Activity." Smiths. Misc. Coll., **89**, 15, pp. 1—52.

Det Danske Meteorologiske Institut, (Annually). "Isforholdene i de Arktiske Have." Copenhagen.

de Boer, H. J., and W. Euwe (1949). "On long-periodical temperature variations." Koninkl. Magn. en Meteor. Observatorium Batavia, Verhandl. 35, pp. 1—16.

Hanzlik, S. (1930). "Der Luftdruckeffekt der Sonnenfleckenperiode." Gerl. Beitr. Geoph., **28**, pp. 114—125.

Iselin, C. O'D. (1940). "Preliminary Report on Long-Period Variations in the Transport of the Gulf Stream." Pap. in Phys. Oceanog. and Meteor., **8**, 1, pp. 1—40.

Jensen, Ad. S. (1939). "Concerning a Change of Climate During Recent Decades in the Arctic and Sub-Arctic Regions, from Greenland in the West to Eurasia in the East, and Contemporary Biological and Geophysical Changes." Biol. Meddel., **14**, 8, pp. 1—76.

Kiilerich, A. (1945). "On the Hydrography of the Greenland Sea." Meddel. Grønland, **144**, 2, pp. 1—63.

Kincer, J. P. (1933). "Is Our Climate Changing? A Study of Long-Time Temperature Trends." Mo. Wea. Rev., **61**, pp. 251—259.

Kincer, J. P. (1946). "Our Changing Climate." Trans. Am. Geophys. Un., **27**, pp. 342—347.

Koch, L. (1945). "The East Greenland Ice." Meddel. Grønland, **130**, 3, pp. 1—374.
Köppen, W., and R. Geiger (Editors) (1939). "Handbuch der Klimatologie", **3**, Pt. N. Berlin, G. Borntraeger.
le Danois, Ed. (1934). "Les Transgressions Océaniques." Off. Sci. Techn. Pêches Marit., Rev. des Travaux, **7**, Fasc. 4, No. 28, pp. 369—462.
Liljequist, G. (1943). "The Severity of the Winters at Stockholm 1757—1942." Meddel. Ser. Upps., Meteor.-Hydrog. Anst., No. 46.
Lysgaard, L. (1937). "Änderungen des Klimas von Dänemark." Met. Zs., **54**, pp. 109—112.
Meinardus, W. (1906). "Periodische Schwankungen der Eisdrift bei Island." Ann. d. Hydr., **34**, pp. 148—162.
Nansen, F. (1924). "Blandt Sel og Bjørn. Min første Ishavs-Ferd." Kristiania.
Schell, I. I. (1940). "Polar Ice as a Factor in Seasonal Weather." Mo. Wea. Rev., Suppl. No. 39, pp. 27—56.
Schell, I. I. (1943). "The Sun's Spottedness as a Possible Factor in the Terrestrial Pressure." BAMS, **24**, pp. 85—93.
Schell, I. I. (1947). "Dynamic Persistence and Its Applications to Long-Range Foreshadowing." Harvard Met. Stud., No. 8, Milton, Mass., pp. 1—80.
Scherhag, R. (1939). "Die gegenwärtige Milderung der Winter und ihre Ursachen." Ann. d. Hydr., **67**, pp. 292—303.
Shaw, N. (1936). "Manual of Meteorology", **II**, pp. 244—246 (2d Ed.), MacMillan, New York.
Smith, E. H. (1931). "The Marion Expedition to Davis Strait and Baffin Bay." Pt. 3. U.S. Coast Guard Bull., No. 19, pp. 1—221.
Thoroddsen, T. (1884). "Den Grönlandska drifisen vid Island." Ymer, pp. 145—160.
U.S. Coast Guard (1947). International Ice Observation and Ice Patrol in the North Atlantic Ocean." Bull. No. 32, pp. 1—188.
Walker, G. T., and E. W. Bliss (1932). "World Weather", V, VI.
Wexler, H. (1950). "Possible effects of ozonosphere heating on sea-level pressure." J. Met., **7**, pp. 370—381.
Wiese, W. (1924). "Polareis und Atmosphärische Schwankungen." Geogr. Ann., **6**, pp. 273—299.
Willett, H. C. (1949a). "Final Report of the Weather Bureau." Massachusetts Institute of Technology Extended Forecasting Project for the Fiscal Year July 1, 1948—June 30, 1949. Cambridge, Mass.
Willett, H. C. (1949b). "Long-Period Fluctuations in the General Circulation of the Atmosphere." J. Met., **6**, pp. 34—50.
Zubov, N. N. (1945). "L'dy Arktiki" (Ice of the Arctic). Chief Northern Sea Route Administration, Moscow, pp. 1—360 (298—299).

Note préliminaire sur les Sparidés des Côtes du Maroc.

Par

René Coupé.

SUR les trente et une espèces qui d'après H. W. Fowler (le seul auteur traitant la question dans son ensemble) peuplent la côte occidentale d'Afrique dont le Maroc fait partie nous n'en avons déterminé que 19 avec certitude.

Ceux des Sparidés qui ont une vaste répartition géographique (Méditerranée, côtes d'Europe et d'Afrique jusqu'au delà du Tropique) y sont naturellement bien représentés. Tel est le cas de *Dentex maroccanus* (Cuv. et Val. 1830), *Dentex vulgaris* (Val. 1836), *Chrysophrys aurata* (Cuvier 1829), *Pagrus pagrus* (Linné 1758), *Pagellus acarne* (Risso), *Pagellus centrodontus* (Val. 1836), *Pagellus erythrinus* (Linné 1758), *Diplodus sargus* (Linné 1758), *Diplodus vulgaris* (Geoffroy), *Diplodus annularis* (Linné 1758), *Puntazzo puntazzo* (Cetti), *Box boops* (Linné), *Box salpa* (Val.), *Cantharus lineatus* (Montagu).

Les espèces plus typiquement africaines (tropicales) y sont rarissimes sinon totalement absentes: *Dentex canariensis* (Steindachner 1881), *Dentex multidens* (Val. 1830), *Chrysophrys heterodus* (Peters 1876), *Chrysophrys coeruleostictus* (Val. 1830), *Chrysophrys gibbiceps* (Val. 1830), *Pagrus auriga* (Val. 1836), *Pagrus ehrenbergii* (Val. 1830), *Diplodus capensis* (Smith 1849), *Lethrinus atlanticus* (Cuv.).

D'autre part certaines espèces comme *Dentex filosus* (Val. 1836) et *Pagrus ehrenbergii* (Val. 1830) citées à la fois de la Méditerranée et de la zone tropicale de l'Atlantique africain et qu'il serait logique de trouver au Maroc ne semblent pas figurer dans la faune de ce pays.

Enfin, certaines autres espèces comme *Dentex macrophthalmus* (Bloch), *Pagellus bogaraveo* (Br. 1764) et *Pagellus mormyrus* (Linné 1768), rares dans le secteur nord du Maroc deviennent abondantes dans le secteur sud (à partir du Cap Cantin).

On peut donc considérer que la zone marocaine, en ce qui concerne les Sparidés, a des affinités plus septentrionales qu'africaines et que c'est vers le Cap Cantin seulement que les tendances vraiment africaines (tropicales) commencent à se manifester.

Note sur *Pagellus acarne* (Risso).

Par

René Coupé.

I. Répartition géographique.

Cette espèce existe depuis le Golfe de Gascogne jusqu'à la Mauritanie. Elle est abondante tout le long des côtes marocaines.

II. Répartition bathymétrique.

(a) Des mensurations effectuées en Mars 1949 (Tableau 1) nous montrent une répartition des tailles, donc de l'âge, variant avec la profondeur.

A 50 mètres une classe jeune (17 cm.) et une classe intermédiaire (20 cm.), la plus forte, prédominent.

A 100 mètres la classe jeune n'existe pratiquement pas; une classe plus âgée (26 cm.) la remplace.

Tableau 1.

Taille en cm.	Fonds de 50 mètres		Fonds de 100 mètres	
	Fréquence	Pourcentage	Fréquence	Pourcentage
14	2	0·4	—	—
15	4	0·8	—	—
16	24	4·7	—	—
17	**65**	**12·6**	—	—
18	51	9·9	1	0·7
19	68	13·2	7	4·5
20	**88**	**17·1**	**31**	**19·8**
21	61	11·8	**32**	**20·4**
22	43	8·4	15	9·6
23	30	5·8	11	7·0
24	19	3·7	11	7·0
25	18	3·5	10	6·4
26	21	**4·1**	**14**	**8·8**
27	5	1·0	12	7·7
28	8	1·6	4	2·6
29	4	0·8	6	3·5
30	3	0·6	1	0·7
31	—	—	2	1·3
	514	100 %	157	100 %

(b) Entre Janvier et Juin 1950 des mensurations portant sur 1936 *Pagellus acarne* pris au chalut par fonds de 80 à 100 m. et 139 autres par fonds de 200 m. (Tableau 2) permettent de constater à nouveau que *Pagellus acarne* s'enfonce de plus en plus, au fur et à mesure qu'il vieillit.

D'autre part les jeunes qui se trouvaient par fonds de 80—100 m. en Janvier sont plus près de la côte en Juin tandis que les plus âgés sont remontés à 80—100 m. Ce déplacement semble coïncider avec la remontée des eaux de pente vers le rivage et l'évolution des pagels vers la pleine maturité sexuelle.

III. Caractères morphologiques (voir Tableau 3).

Les valeurs relatives, par rapport à la longueur totale, de longueur de la tête, hauteur du corps, distance prédorsale, distance préventrale, distance préanale, espace entre nageoires ventrale et anale, augmentent avec la taille et l'âge.

Tableau 2.

	80—100 m.										200 m.	
	Janvier		Février		Mars		Avril		Juin		Mars	
Taille en cm.	fré-quence	%	fré-quence	%	fré-quence	%	fré-quence	%	fré-quence	%	fré-quence	%
12	—	—	1	0·3	—	—	—	—	—	—	—	—
13	6	0·6	2	0·7	—	—	1	0·2	—	—	—	—
14	3	0·3	0	0	—	—	0	0	—	—	—	—
15	18	1·9	1	0·3	—	—	8	1·7	—	—	—	—
16	35	3·7	9	3·1	—	—	13	2·8	—	—	—	—
17	156	16·5	25	8·6	4	7·3	45	**10·8**	—	—	—	—
18	177	**18·8**	39	**13·5**	15	27·3	19	4·2	—	—	—	—
19	139	14·7	29	10·0	8	14·5	30	6·7	2	1	2	1·4
20	128	13·7	35	12·1	8	14·5	66	14·7	9	4·5	10	7·2
21	80	8·5	31	10·7	3	5·5	62	13·4	18	9·1	15	**10·8**
22	63	6·7	33	11·4	4	7·5	70	**15·6**	23	11·6	13	9·4
23	44	4·7	26	9·0	3	5·5	34	7·6	28	14·1	13	9·4
24	34	3·6	20	6·8	5	9·1	24	5·3	25	12·6	8	5·8
25	26	2·8	11	3·8	2	3·6	24	5·3	30	15·1	8	5·8
26	11	1·2	11	3·8	1	1·8	12	2·6	17	8·5	10	7·2
27	9	1·0	10	3·5	1	1·8	14	3·1	16	8·0	7	5·0
28	6	0·6	5	1·7	1	1·8	11	2·4	10	5·0	10	7·2
29	4	0·4	1	0·4	—	—	5	1·1	11	5·5	15	**10·8**
30	1	0·1	1	0·3	—	—	6	1·3	3	1·5	10	7·2
31	2	0·2	—	—	—	—	3	0·6	2	1·0	7	5·0
32	1	0·1	—	—	—	—	1	0·2	2	1·0	6	4·3
33	—	—	—	—	—	—	1	0·2	3	1·5	1	0·7
34	—	—	—	—	—	—	—	—	—	—	2	1·4
35	—	—	—	—	—	—	—	—	—	—	1·0	0·7
36	—	—	—	—	—	—	—	—	—	—	1	0·7
Totaux	943	100	290	100	55	100	449	100	199	100	139	100

Quant aux longueurs relatives de la pectorale et de la base de la dorsale elles varient peu et peuvent être considérées comme constantes.

Par rapport à la longueur de la tête, la valeur relative des distances post-orbitaire et pré-orbitaire augmente avec la taille, la première moins rapidement que la seconde ce qui signifie que le diamètre de l'orbite se développe moins vite que la longueur de la tête.

IV. Caractères méristiques.

(a) Formule vertébrale. Le nombre des vertèbres est constant et égal à 23.

Tableau 3. Valeurs relatives des différentes Parties du Corps pour *Pagellus acarne* (Risso).

Groupe de		15 cm.	20 cm.	25 cm.	30 cm.	35 cm.
Nombre		36	40	17	6	5
Moyenne		de 13 à 17 cm. 15.79	de 18 à 22 cm. 19.05	de 23 à 27 cm. 25.35	de 28 à 32 cm. 29.67	33 à 37 cm. 34
$\frac{100}{LT}$	T	25·500	25·625	25·765	26·333	26·400
$\frac{100}{LT}$	H. C.	23·639	24·666	26·588	26·666	27·400
$\frac{100}{LT}$	P. D.	30·750	31·050	32·000	33·333	33·834
$\frac{100}{LT}$	P. V.	30·138	30·050	31·117	32·166	31·800
$\frac{100}{LT}$	P. A.	50·000	50·325	51·000	51·333	52·000
$\frac{100}{LT}$	P.	24·222	24·525	24·176	25·000	24·400
$\frac{100}{LT}$	V.	15·862	15·272	16·058	15·500	15·750
$\frac{100}{LT}$	B. D.	39·757	40·051	40·530	40·000	40·000
$\frac{100}{LT}$	B. A.	14·743	14·525	14·648	14·333	13·600
$\frac{100}{LT}$	V. A.	23·666	24·100	24·588	24·834	25·200
$\frac{100}{T}$	Post. O	60·889	61·975	63·589	64·000	64·200
$\frac{100}{T}$	Pr. O	32·166	33·300	35·117	36·666	37·000
$\frac{100}{T}$	— O	28·750	28·500	28·411	27·666	27·200

(b) Formule radiaire de la nageoire dorsale. Pour 104 individus le nombre des rayons se répartit ainsi :

— 12 rayons durs + 11 rayons mous (XII + 11) : pour 99 individus soit 95·2 % du total.

— 13 rayons durs + 10 rayons mous (XIII + 10) : pour 5 individus soit 4·8 % du total.

(c) Formule radiaire de la nageoire ventrale. Le nombre des rayons est constant : 1 rayon dur + 5 rayons mous (I + 5).

V. Sexualité.

Les cas d'hermaphrodisme sont fréquents chez cette espèce; 58 individus étudiés à ce point de vue se répartissent comme suit :

mâles	26	soit 44·8 %	du total
femelles	25	soit 43·1 %	—
hermaphrodites . . .	7	soit 12·1 %	—

Tous les hermaphrodites présentaient 4 glandes : testicule et ovaire droit, testicule et ovaire gauche, accolés l'un à l'autre et également développés.

Parasites du *Germo alalunga* (J. F. Gmelin 1788).

Par

Robert Ph. Dollfus,

Muséum National d'Histoire Naturelle, Paris,
Laboratoire de Parasitologie comparée.

UN inventaire des parasites du Germon a été publié en 1940 par R. Ph. Dollfus pour les Helminthes et René Legendre pour les Copépodes (voir René Legendre 1940, p. 275—288, Fig. 67—71), mais cet inventaire ayant dû subir des modifications et des additions, la liste ci-dessous a été dressée.

TREMATODA MONOGENA.

Fam. **Capsalidae** W. Baird 1853

Capsala thynni (J. Guiart 1938) N. G. Sproston 1947 — Branchies

TREMATODA DIGENEA.

1° Fam. **Hirudinellidae** R. Ph. Dollfus 1932

Hirudinella fusca (L. A. G. Bosc 1802) R. Ph. Dollfus 1932 — Estomac

Hirudinella poirieri (R. Moniez 1891) R. Ph. Dollfus 1935 — — d° —

Hirudinella oxysoma J. Guiart 1938 — — d° —

Hirudinella spinulosa S. Yamaguti 1938 — — d° —

Il est possible que toutes ces 4 espèces tombent en synonymie d'*Hirudinella marina* Garcin 1730, mais cela n'est pas définitivement démontré.

2° Fam. **Didymozooïdae** (F. S. Monticelli 1888) nom. emend.

Didymocystis guernei (R. Moniez 1890)	Par paires dans des kystes	Cavité branchiale
Didymocystis thynni (E. O. W. Taschenberg 1879) R. Ph. Dollfus 1926	— d° —	Branchies et rein
Didymocystis wedli V. Ariola 1902	— d° —	Branchies

Didymocystis lanceolata J. Guiart 1938[1])	Par paires dans des kystes	Arcs branchiaux
Didymocystis macrorchis J. Guiart 1938[1])	— d° —	Branchies
Didymocystis alalongae S. Yamaguti 1938	— d° —	Arcs branchiaux
Didymocystis opercularis S. Yamaguti 1938	— d° —	Face interne de l'opercule
Wedlia bipartita (K. Wedl 1855) Th. Sp. Cobbold 1861	— d° —	Branchies et rein
Wedlia orientalis S. Yamaguti 1934	— d° —	Muqueuse intestinale
Platocystis alalongae S. Yamaguti 1938	— d° —	Peau
Metanematobothrium guerni (R. Moniez 1860) S. Yamaguti 1938	Muscles sous-maxillaires et muqueuse intestinale	
Nematobothrium latum J. Guiart 1938[1])	Kyste du péritoine stomacal	

CESTODA TETRARHYNCHIDEA.

Fam. **Hepatoxylidae** R. Ph. Dollfus 1940

Hepatoxylon trichiuri (H. S. Holten 1802) R. Ph. Dollfus 1942	Estomac : sur paroi externe et sur paroi interne
= *Hepatoxylon squali* L. A. G. Bosc 1811	
= *Tetrarhynchus grossus* Rudolphi 1819 (Postlarve)	

Fam. **Sphyriocephalidae** R. Ph. Dollfus 1930

Sphyriocephalus tergestinus Th. Pintner 1913 (Postlarve)	Caecum stomacal

CESTODA PSEUDOPHYLLIDEA.

Fam. **Amphicotylidae** O. Nybelin 1922

Pseudobothrium grimaldii Jules Guiart 1935[2])	Estomac, caeca pyloriques et duodenum

NEMATODA.

Fam. **Ascaridiidae** (W. Baird 1853) emendata.

Contracaecum (Thynnascaris) legendrei R. Ph. Dollfus 1933	Estomac
Contracaecum sp. (larve encapsulée)	Péritoine

[1]) La validité des espèces créées per Jules Guiart n'est pas encore définitivement admise.

[2]) L'anatomie de cette espèce étant inconnue, il n'est pas possible de se prononcer sur sa validité.

ACANTHOCEPHALA.

Fam. **Polymorphidae** Anton Meyer 1931	
Bolbosoma vasculosum (Rudolphi 1819) (larve encapsulée)	Musculature en avant des rayons épineux de l'anale ou entre ces rayons
Fam. **Rhadinorhynchidae** L. Travassos 1923	
Rhadinorhynchus pristis (Rudolphi 1802)	Estomac

COPEPODA.

Fam. **Caligidae** (H. M. Edwards 1840)	
Caligus alalongae H. Kröyer 1863	Peau
Elytrophora brachyptera A. Gerstaecker 1853	Lames branchiales et face interne de l'opercule
Fam. **Dichelesthiidae** (H. M. Edwards 1840)	
Pseudocycnus appendiculatus C. Heller 1865	— d° —
Fam. **Lernaeopodidae** (H. M. Edwards 1840)	
Brachiella thynni G. Cuvier 1830	Aisselle des pectorales
Fam. **Pennellidae** (W. Baird 1850)	
Pennella germonia W. H. Leigh Sharpe 1931	Peau

Echo-Surveys of Fish.

By

D. H. Cushing.

Introduction.

Echo-sounders have been used extensively for finding fish (Balls 1948, Hodgson 1950, Tester 1943, Renou and Tchernia 1947), and Runnström (1941) has shown that it is possible to survey for fish along bearings. This paper introduces two developments:—

1. The counting of fish traces as separate transmissions on the recording paper.
2. The combination of the information from an area to give a consistent picture of the distribution of pelagic fish.

Method.

On plankton surveys in R. V. "Sir Lancelot" since April 1948, it has been necessary to cover wide areas of the sea off the north-east coast of England and in the English Channel. These areas have been surveyed with the use of a squared grid of stations, the lines of which have been set at 25 or 30 miles distance; each station along the cruise track was 15 miles apart. Between these stations, an M.S. XII echo-sounder (made by Kelvin and Hughes (Marine Instruments Ltd.)) was run continuously, using the fathom scale.

In 1948 a 2-stage amplifier was used, and in 1949 a 3-stage amplifier took its place; this means that cruises done in these years are not comparable, except qualitatively. These amplifiers were put at a constant setting; so was the initial suppression. The result of these settings was to achieve a short transmission noise from the surface and then, a clean stretch of paper to the point at which the bottom was marked. The initial suppression clears surface and ship noises from the paper and the setting of the amplifier is such that it is just below the point at which noise appears right across the paper.

As the stylus revolves, the paper moves slowly. A trace is made up of successive markings, which, because of the slow speed of the paper, become superimposed upon one another. Consequently, if the paper is

pulled through the machine at a faster speed, single marks will be made on the paper by the stylus. The paper may also be pulled through and allowed to stop whilst the stylus marks the paper twice, three times, etc. In this way, compound soundings may be built up. The width of these compound soundings may be measured and the relation between the width of trace and number of soundings is shown in Figure 1; this is expressed graphically in Figures 2 and 3. The relation is linear and it is a different one for each of the styli used. Thus the instrument must be recalibrated every time the stylus is changed.

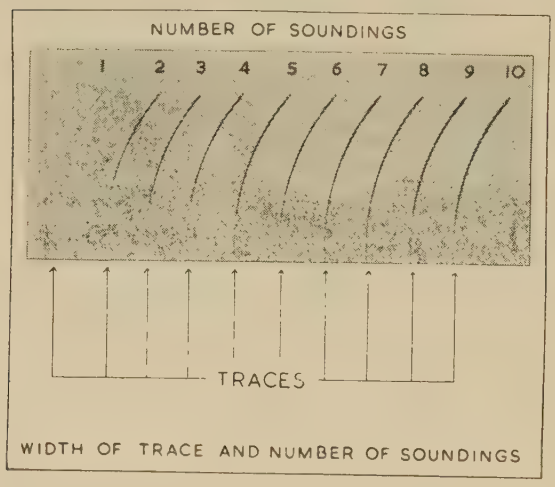


Figure 1. Width of traces and number of soundings. These are compound soundings that have been marked on the paper and photographed.

Using these graphs it is possible to measure fish traces and to convert them to numbers of soundings. Measurement was made with a Reichert binocular microscope (X 10 eyepieces, $^2/_3$ objective), using blue transmitted light and an eyepiece micrometer. A trace shades off at the edges and in measurement it is necessary to use some convention; one might measure the fully black width or one might include the edges of the finest shading, or again, the mean between the two might be used. I used the fully black width at the widest part of the trace. In extensive use, it would probably be better to adjust the paper speed of the recorder to one that separates the soundings on the paper, so that they can be counted without a microscope. Certain rough surveys have been done quite successfully by measuring the large traces with a ruler.

In working up the results, the echo-paper was examined in the strips that had come off the machine between plankton stations. At the midpoints between plankton stations on the chart "echo-stations" were set up. Each "echo-station" on the chart was marked with the number of soundings on fish that had been counted between plankton stations. From these numbers a contoured chart was made. This chart of echoed fish I shall call an echo-chart.

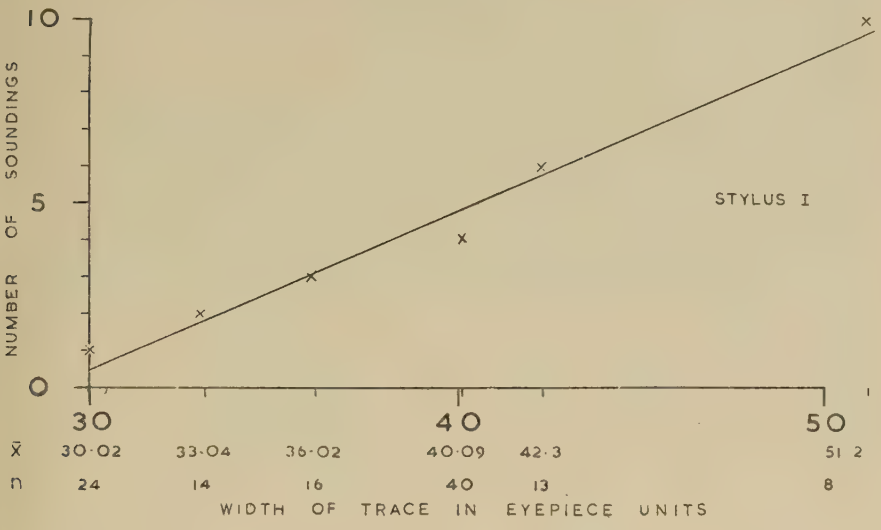


Figure 2. Number of soundings and width of trace in eyepiece units for Stylus I. $\bar{x}$ is the mean of observations, n is the number of observations.

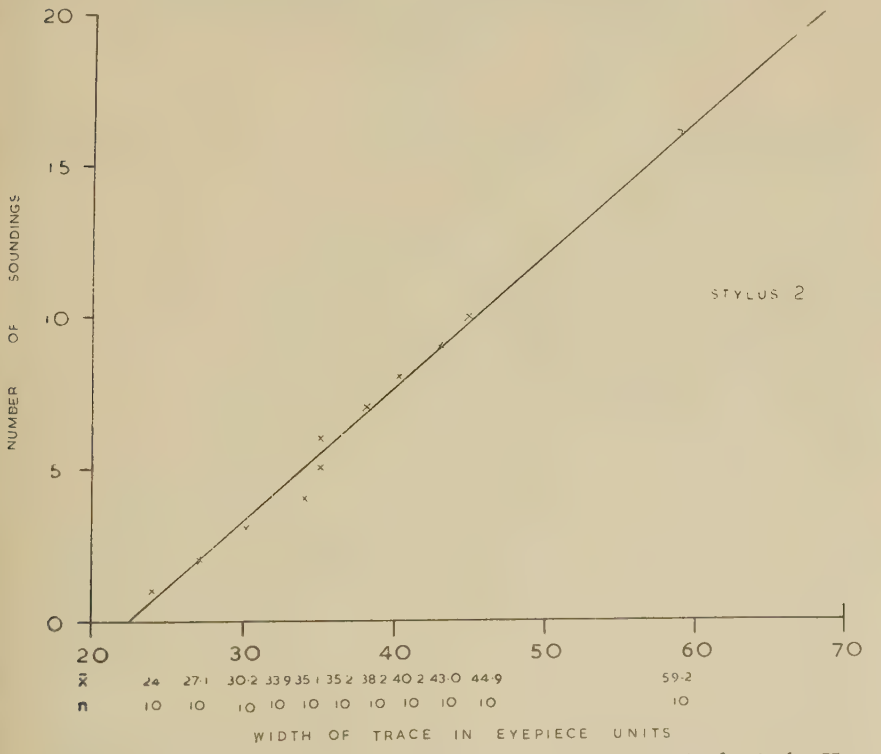


Figure 3. Number of soundings and width of trace in eyepiece units for Stylus II. $\bar{x}$ is the mean of observations, n is the number of observations.

Results.

1. Comparison with Fish Landings.

Figure 4 shows an echo-chart of an area off Shields; the densely lined patches are those in which soundings were most plentiful. The dotted lines surround areas in which mean catches of herring per 5 miles along bearings from Shields were concentrated during the period of the cruise. The inner dotted lines surround areas of higher density. The heaviest fishing during the period of this cruise was taking place within the area of the echo-patch nearest Shields. Thus fish are in catchable numbers within the echo-patch.

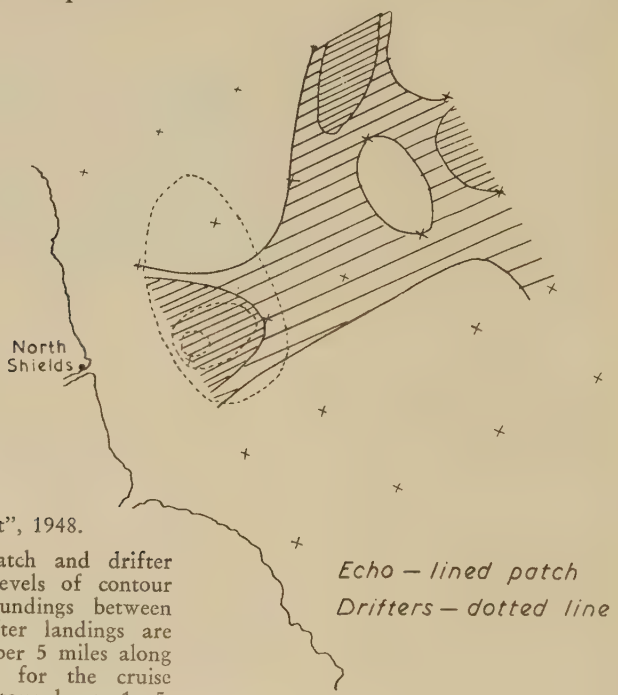
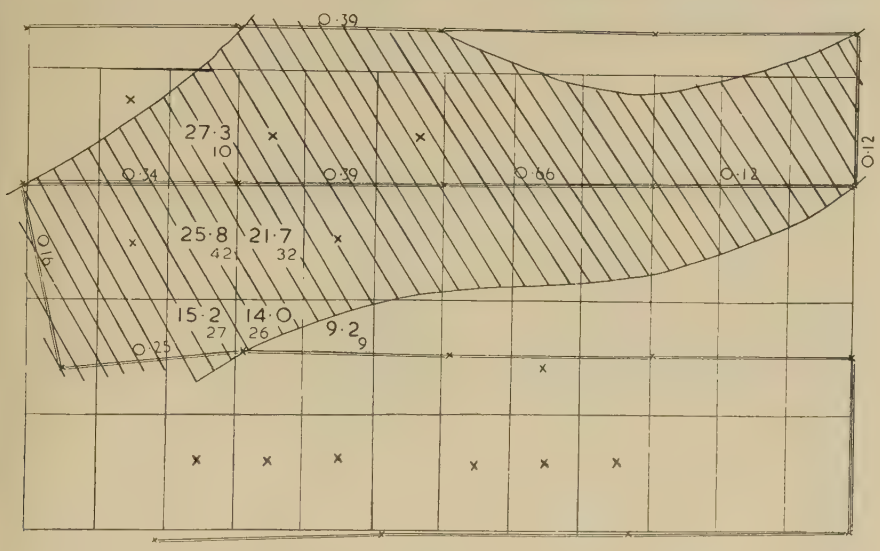


Figure 4.
Cruise XI, "Sir Lancelot", 1948.

Comparison of echo-patch and drifter landings. Echo-patch levels of contour are 1—5 and 5+ soundings between plankton stations. Drifter landings are plotted as mean catch per 5 miles along bearings from Shields, for the cruise period; these are contoured at 1—5, 5—10, and 10+ crans.

Figure 5 shows an echo-chart of an area near the Dowsing herring fishery. The fishery is plotted as mean catch in crans per statistical square, and the number of boats contributing to that mean is given as a suffix. The echo-chart in this case is plotted in soundings per distance because the ship's speed varied considerably during the cruise. The mean catches within the echo-patch are in most cases above 5 crans and outside the patch the catches were not plentiful enough to make a comparison. Thus, heavy landings occur within the echo-patch and few boats were fishing outside it.

Figure 6 shows a similar comparison made by M.V. "Clupea" which is also fitted with an M.S. XII echo-sounder; here, again, soundings per



KEY

Numbers on cruise track ... 0.39 x——x

Echo units (contoured) ... \\\\\\

Numbers in statistical squares ... Mean catch in crans

Suffix ..... Number of boats/square

(x < 5 „ „)

Figure 5. Echo-Survey, "Sir Lancelot", Cruise XX, 1948.
Comparison of echo-patch and drifter landings. The echo-patch surrounds the area in which soundings on fish were observed. Drifter landings are expressed in mean catch in crans per statistical square, for the 3 days that included the cruise period.

distance were used because of the variable speed of the ship. A tidal grid was used on this cruise; normally, on a squared grid, the distance between lines of stations is greater than the estimated fetch of the tidal streams in the area. Figure 6 shows the cruise track running from the lettered points A B C D E F G H; both A B C D and E F G H were completed in 12 hours. Thus the lines A B and E F were carried out at about the same state of tide; the same thing may be said about the lines C D and G H. With this method the survey becomes more sensitive and 2nd and 3rd levels of echo-density correspond to the higher values in the statistical squares.

There are disadvantages to this sort of comparison:—

(i) Of two equally dense patches of fish, a drifter skipper will always use that nearer home. Figure 4 shows an echo-patch about 60 miles north-east of Shields, with no drifters near it. This does not mean that the echo-observations in the distant patch were wrong ones.

(ii) Drift-nets do not fully sample a pelagic fish population, because of mesh selection and possibly depth selection (in those fisheries where the fish remain deep at night).

(iii) Collectors at the ports do not know to within 5 miles where a particular drifter skipper has been working.

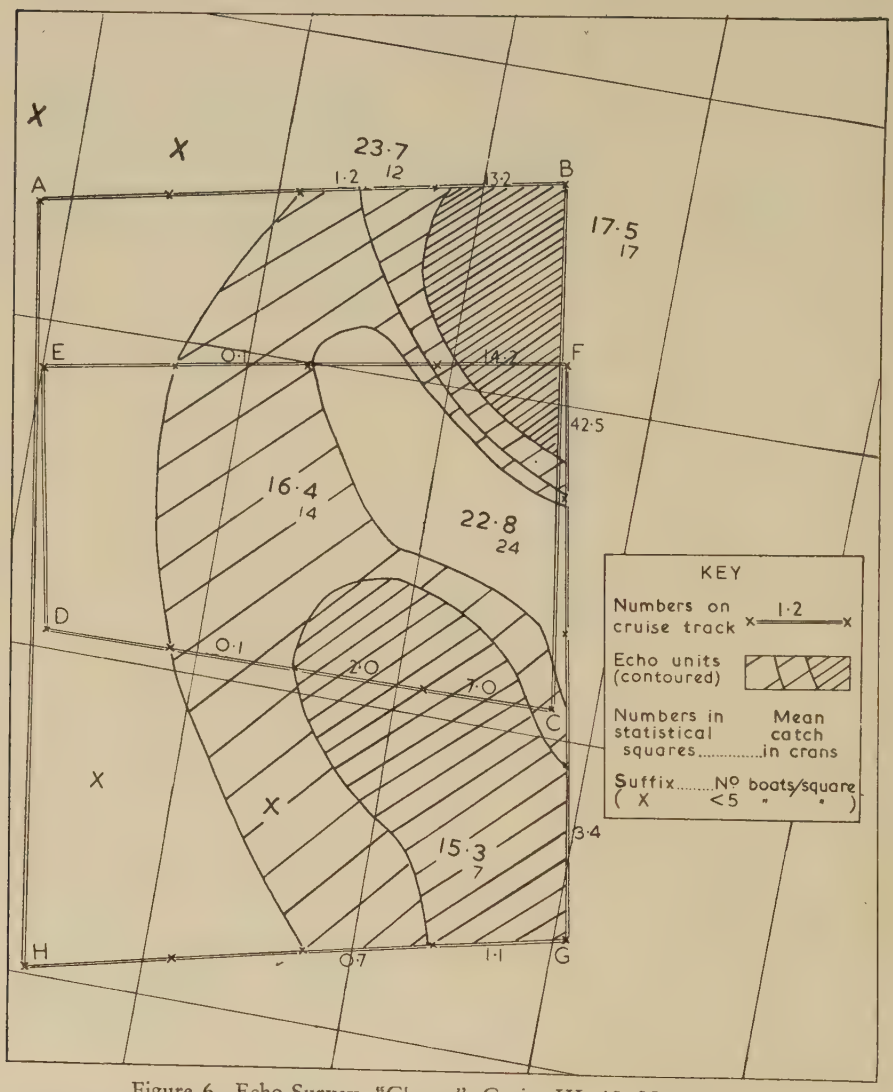


Figure 6. Echo-Survey, "Clupea", Cruise III, 15. Nov. 1949.
Comparison of echo-patch and drifter landings. The soundings on fish are expressed as numbers of soundings per distance steamed between stations; these are contoured at 0—1, 1—10, 10+. Drifter landings are expressed in mean catch per statistical square for the 24 hours of the cruise period.

Taking these disadvantages, it is remarkable that such a good comparison between echo-surveys and fish landings has been obtained.

2. Repetition.

During a survey, the "Sir Lancelot" was steaming towards Shields and a number of strong echoes were seen on the paper. Two whales

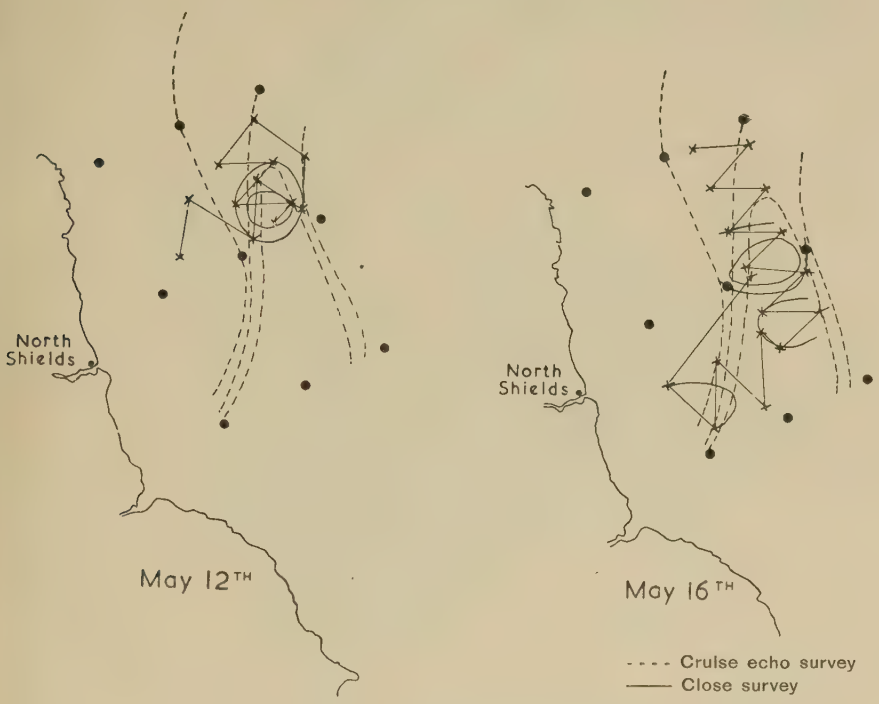


Figure 7. Cruise VIII, "Sir Lancelot", May 1949.
Two close surveys of a small area over the south-west toe of the North-East Bank.

were seen in the area and a dozen gannets were fishing. I saw fish on the surface for the first time. It was decided to do a quick survey of this area to find its limits; the cruise track of this close survey is shown in thin line on Figure 7 (12. May). The echo-patch found in the area is shown in full line. The echo-patch found from the cruise survey, taken from a very much wider area, is shown in dotted line. On 16. May the close survey was repeated in the same way and an echo-patch of comparable density was found in the same place. On Close's Fisherman's Chart this is shown as the south-west toe of the North-East Bank; on the night of 11.—12. May, the night before the first survey was done, four catches were made here of between 19 and 26 crans. High catches, the traditional signs, coincidence between close survey and cruise survey, and the constancy of the echo-patch in time, all combine to give confidence in the method.

3. Comparison with Pilchard Egg Distribution.

Figure 8 shows the distribution of echo-patches (lined patches of two densities) and the distribution of stage I pilchard eggs. Patches of eggs are shown at a density of more than 10 per m^3., as caught by the Helgoland larva net. At three stations at which there were more than

Figure 8. Cruise XI, "Sir Lancelot", 1949.
Comparison of echo-patch and the distribution of Stage-I pilchard eggs.

100 eggs of all stages, owing to a failure in preservation, it was impossible to stage them; from the distribution of stages at the other stations, it is very reasonable to include these stations amongst those of more than 10 stage I eggs per m^3.

In most areas of the English Channel, the comparison between the two distributions is good. There is an echo-patch north of Ushant and one south-west of the Scillies, in which there are no pilchard eggs at all. The fish traces were in one case quite strong, so presumably they were not spawning pilchards. Although some fish can be identified on the echo-sounder (Hodgson 1950, Richardson (in the press)), pilchards cannot be distinguished from the other pelagic fish that would be in the area at that time.

4. Comparison with the Distribution of *Calanus finmarchicus*.

This comparison appears in Figure 9. The echo-survey is drawn in lined patches and is plotted at three levels of density. The distribution of *Calanus finmarchicus* is shown in hatched patches; there are two levels of density, 30 per m^3. and 60 per m^3.

Calanus finmarchicus forms the main food of the herring during May (Hardy 1924, Savage 1931). It is probable that during the feeding season, herring shoals aggregate on to patches of *Calanus*; so

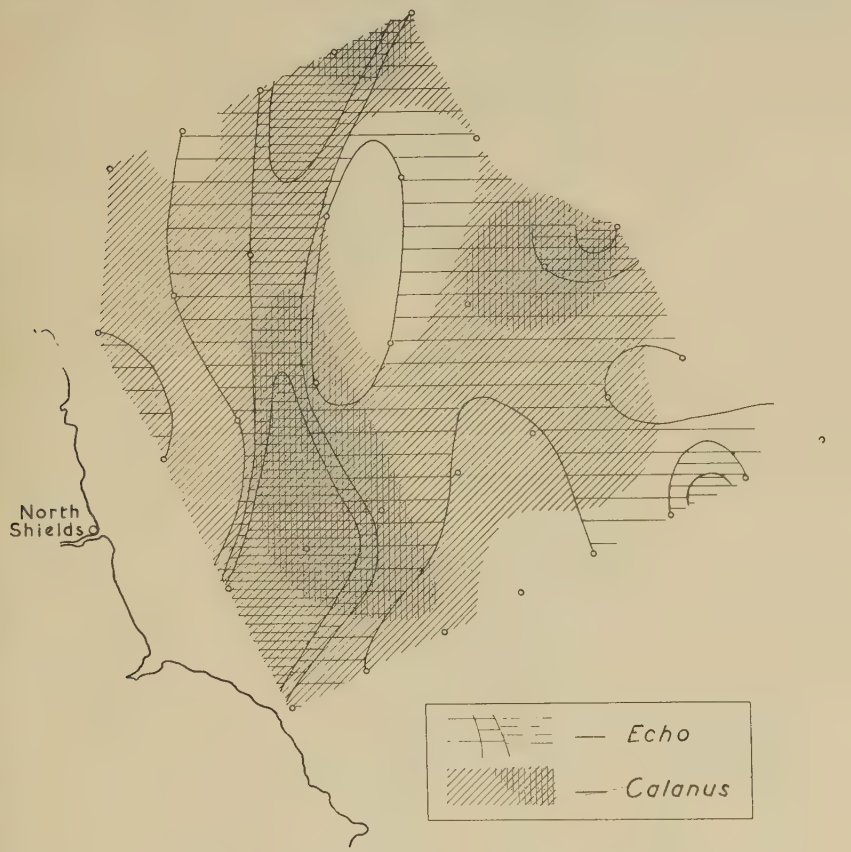


Figure 9. Cruise VIII, "Sir Lancelot", May, 1949.
Comparison of echo-patch and the distribution of *Calanus finmarchicus*. The echo levels of density are 0—5, 5—10, and 10+ per distance steamed between stations. The levels of *Calanus finmarchicus* Stage V are at 10—30 and 30+ per m^3.

long as the grazing intensity of the herring is less than the reproductive effort of the *Calanus*, aggregation will take place and there will be coincidence of herring and *Calanus* patches. This situation probably lasts until the end of May. Hence it is likely that the fish traces in these echo-patches are herring, because there are no other pelagic fish in the area in comparable numbers.

The comparison of the two types of patch in Figure 9 shows that they agree extraordinarily well. This suggests that the echo-sounder as a fish sampling device is as accurate as a Hensen net is for *Calanus*.

5. Echo-Contour Density and Drifter Landings.

Figures 10 and 11 show the relation between echo-patches and the area distribution of drifter catches. As before, the echo-patches are lined, and are plotted at three levels of density. The drifter catches are expressed as mean catches per 5 miles along bearings from

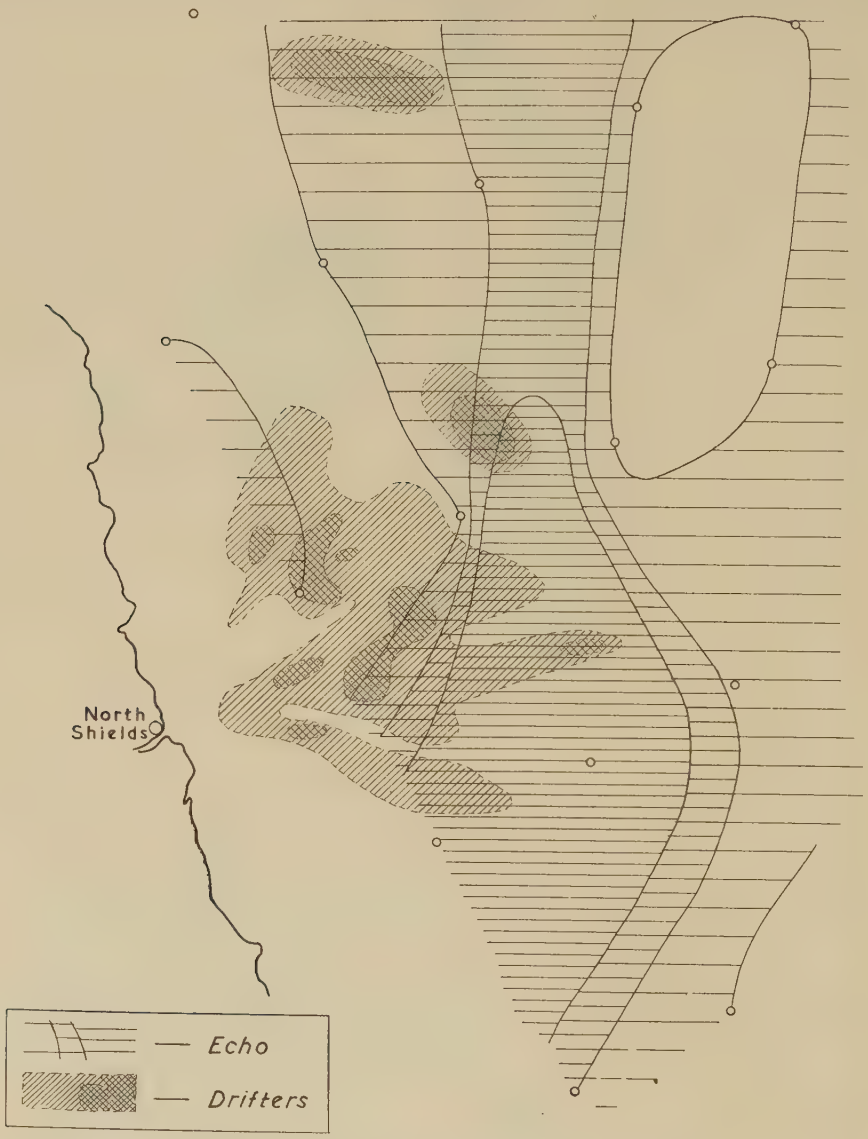


Figure 10. Cruise VIII, "Sir Lancelot", May 1949.
Comparison of echo-patch with the mean catch in crans per 5 miles along bearings from Shields for the cruise period. This mean catch is plotted at 2 levels, 0—10 and 10+.

Shields for the period of the cruise; these mean catches are plotted at their appropriate positions along their bearings and the resulting distribution is contoured at two levels of density. Both Figure 10 and Figure 11 show that denser drifter patches lie within the edges of the

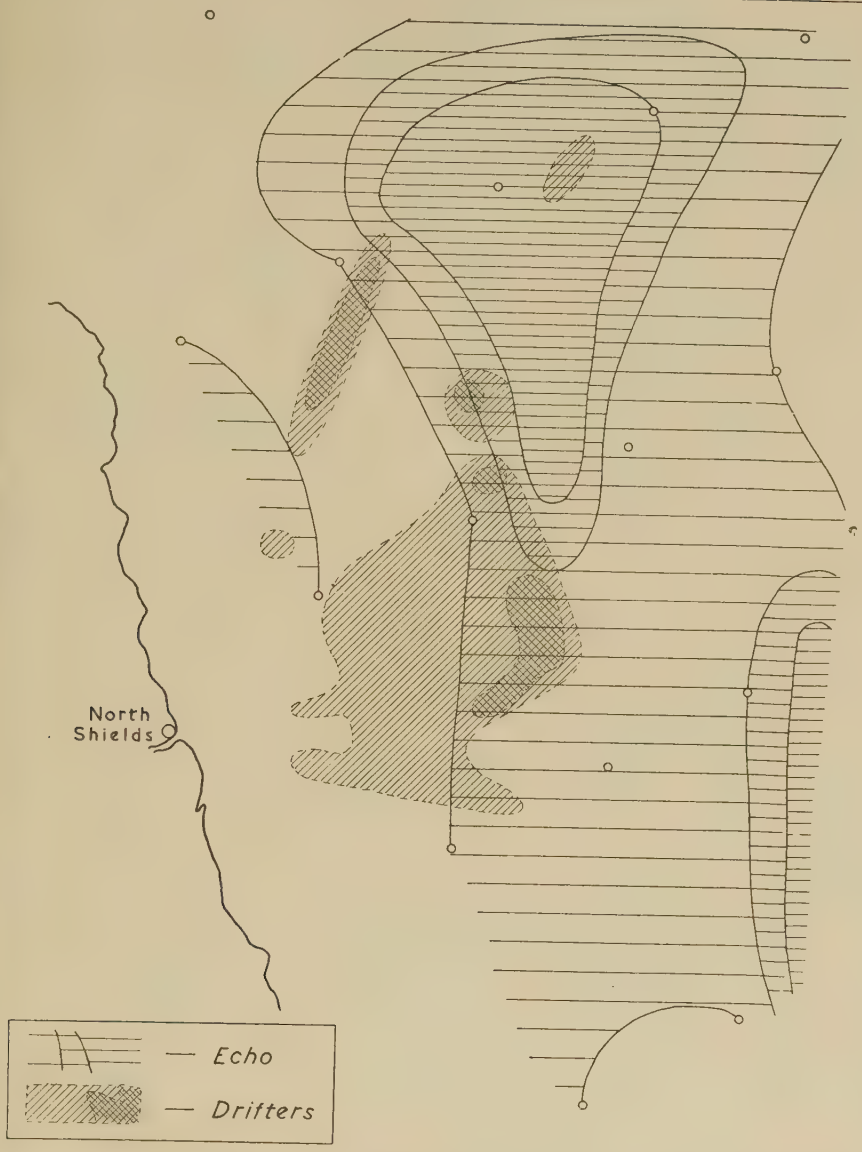


Figure 11. Cruise IX, "Sir Lancelot", 1949.
Comparison of echo-patch with the mean catch in crans per 5 miles along bearings from Shields for the cruise period. This mean catch is plotted at 2 levels, 0—10 and 10+.

echo-patches. They also show that the densest echo-patches are not exploited by the drifters at all. It is true that on Figure 11 there is a small patch in the centre of a dense echo-patch; this, however, is the catch of only one drifter.

Tables 1—7. Soundings on Fish.

Table 1. — Cruise IX — "Sir Lancelot" 1948.

Stations	Width of Soundings (eyepiece units)	Soundings
11—12	40, 30, 25	4, 1, 1
12—12a	45, 35, 25	7, 2, 1
13—14	25, 25	1, 1
15—16	40	4
18—19	40, 35, 30, 25, 25	4, 2, 1, 1, 1
20—21	40, 30	4, 1
21—22	25	1

Note: 12a is a station set up between 12 and 13; the distance between 12 and 12a is equal to that between 13 and 14.

Table 2. Cruise XX — "Sir Lancelot" 1948.

Stations	Number of Soundings	Soundings per Time
8—9	9	·25
9—10	7	·16
10—11	15	·34
11—12	15	·39
12—13	28	·66
13—14	4	·12
14—15	7	·12
17—18	41	·39

Note: "Number of Soundings" is a relative estimate made by measuring traces with a ruler.

Table 3. Cruise III — "Clupea" 1949.

Stations	Number of Soundings	Distance	Soundings per Distance	Stations	Number of Soundings	Distance	Soundings per Distance
1—2	—	5	—	12—13	0·5	5	0·1
2—3	—	5	—	13—14	—	5	—
3—4	6·0	5	1·2	14—15	71·0	5	14·2
4—5	66·0	5	13·2	15—16	212·5	5	42·5
5—6	—	15	—	16—17	—	5	—
6—7	35·0	5	7·0	17—18	—	5	—
7—8	10·0	5	2·7	18—19	17·0	5	3·4
8—9	0·3	5	0·1	19—20	5·5	5	1·1
9—10	—	5	—	20—21	3·5	5	0·7
10—11	—	10	—	21—22	—	5	—
11—12	—	5	—	22—23	—	5	—

Note: "Number of Soundings" is a relative estimate made by measuring traces with a ruler.

Table 4. Cruise VIII — "Sir Lancelot" 1949. Close Survey.

	Stations	Width of Soundings (eyepiece units)	Total Soundings
12. May 1949	1—2	23(17), 25(5), 30(3), 35, 40	43
	2—3	25(8), 30(2), 35, 45	29
	3—4	25(4)	4
	9—10	35	5
16. May 1949	5—6	23(3)	3
	6—7	30(3), 35	14
	7—8	30, 50	15
	9—10	30, 35	8
	10—11	23	1
	11—12	23	1
	14—15	25(3)	3
	15—16	23	1
	16—17b	25(3), 35, 28, 30	13

Note: Figures in brackets show the number of recordings of the same width.

Table 5. Cruise XI — "Sir Lancelot" 1949.

Stations	Width of Soundings (eyepiece units)	Total Soundings	Stations	Width of Soundings (eyepiece units)	Total Soundings
1—2	23(2), 33	6	47—48	28(19), 30	41
6—7	23(2)	2	48—49	25(3), 35, 38	14
11—12	25(2), 30, 35	10	49—50	28(4), 30(2), 25, 33, 37	25
12—13	21, 27	3	50—51	30	3
20—21	21, 25, 26, 30	6	58—59	23	1
23—24	21, 28(2), 25, 30(2), 33	16	59—60	35	5
24—25	20, 21(8), 25, 28, 33	16	60—61	30	3
25—26	25(7), 28, 31, 32	16	61—62	40	7
26—27	22, 30	4	62—63	35	5
28—29	30(3)	9	67—68	28(2), 25, 30	8
31—32	21(5), 25(2), 28(2)	11	68—69	30(2), 33	10
32—33	22	1	70—71	22(3)	3
34—35	22, 25(2), 27, 30	8	71—72	22(3), 30	6
35—36	32	4	72—73	23(23)	23
37—38	21, 25, 20, 30, 35, 38	17	73—74	21, 23(3), 35(3)	19
38—39	25(3)	3	76—77	35	5
40—41	20(2), 28(3), 31, 35	16	77—78	40	7
41—42	40	7	79—80	25(17), 30	20
46—47	30	3	85—86	25, 26	2

Note: Figures in brackets show the number of recordings of the same width.

Table 6. Cruise VIII — "Sir Lancelot" 1949.

Stations	Width of Soundings (eyepiece units)	Total Soundings
1—2	23(2)	2
2—3	30(2), 32	10
3—4	23(2)	2
7—8	24(2)	2
8—9	23(8), 25, 26, 30, 35 36, 50	35
9—10	22(6), 25, 29, 44	17
10—11	22(6), 30, 33	13
11—12	27	2
13—14	23(3)	3
15—16	22(2)	2
16—17	32, 35(2)	14
17—18	35	5
18—19	22(2)	2
20—21	23(3), 25, 28, 30, 50	21
?—23	23, 21	2
24—25	23	1
25—26	22, 36	6
27—28	22(2), 24	3
29—30	23(4), 40(2)	18
30—31	23(3), 25(2), 30, 40	15
31—32	25(2), 30	5

Note: Figures in brackets show the number of recordings of the same width.

Table 7. Cruise IX — "Sir Lancelot" 1949.

Stations	Width of Soundings (eyepiece units)	Total Soundings
1—2	30	3
2—3	26(2), 30	5
3—4	22(7), 25(2), 30, 33, 40	23
5—6	23	1
6—7	25	1
7—8	30	3
8—9	30, 45	12
11—12	28, 30	5
14—15	21	1
15—16	23, 45	10
17—18	28(2), 35, 55, 70	43
18—19	45(2), 60(4)	82
19—20	35	5
20—21	22, 26	2
21—22	22, 25(2). 28, 32	9
28—29	30	3

21—22
3 occur within
15 miles of Stat. 21.

Note: Figures in brackets show the number of recordings of the same width.

Tables 8 and 9. Mean Catch per 5 miles along Bearings from Shields.

Table 8. Period of Cruise VIII — "Sir Lancelot", May 1949.

Distance from Shields Miles	N.×E.	N.×E.½E.	N.N.E.	N.N.E.½E.	N.E.×N.	N.E.½N.	N.E.	N.E.½E.	N.E.×E.	E.N.E.	E.×N.½N.	E.×N.	E.½N.	E.	E.½S.	E.×S.
0—5	—	—	—	—	—	—	—	—	—	—	—	—	—	*3*	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	3·0	—	—
5—10	—	—	—	—	—	—	—	—	—	—	—	*1*	*2*	*7*	—	—
	—	—	—	—	—	—	—	—	—	—	—	5·2	4·6	10·8	—	—
10—15	—	—	—	—	—	—	—	—	—	*8*	*1*	*36*	—	—	—	*1*
	—	—	—	—	—	—	—	—	—	14·0	4·5	5·0	—	—	—	1·0
15—20	—	—	*18*	*2*	*5*	*1*	*1*	*1*	—	*15*	*8*	*8*	—	*3*	—	*6*
	—	—	6·6	16·0	3·2	25·5	22·8	25·5	—	8·3	1·8	10·7	—	3·5	—	4·2
20—25	—	*1*	*18*	—	*9*	*1*	*4*	*1*	*8*	*5*	*1*	*20*	*3*	—	—	*4*
	—	0·8	3·0	—	4·5	13·0	2·3	13·0	8·6	10·0	11·2	1·6	1·5	—	—	1·5
25—30	—	*1*	*10*	*3*	*2*	—	*3*	—	*5*	*2*	*1*	*13*	*1*	—	—	—
	—	1·2	4·3	4·0	1·0	—	0·8	—	1·0	4·0	0·5	3·0	1·0	—	—	—
30—35	—	—	—	—	—	—	—	—	—	*2*	—	*1*	—	—	—	—
	—	—	—	—	—	—	—	—	—	9·5	—	1·0	—	—	—	—
35—40	—	—	—	—	—	*1*	*3*	*1*	—	—	—	*3*	—	—	—	—
	—	—	—	—	—	4·0	17·8	4·0	—	—	—	15·0	—	—	—	—
50—55	*4*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	21·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
55—60	—	—	*12*	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	22·3	—	—	—	—	—	—	—	—	—	—	—	—	—

Table 9. Period of Cruise IX — "Sir Lancelot" 1949 (22.—30. May).

10—15	—	—	—	—	—	—	—	—	—	—	—	*1*	—	—	—	*2*
	—	—	—	—	—	—	—	—	—	—	—	4·5	—	—	—	0·8
15—20	—	—	—	—	*1*	—	—	*1*	*1*	—	*2*	*43*	*4*	*2*	*15*	*28*
	—	—	—	—	0·5	—	—	9·0	6·8	—	1·4	3·3	2·2	9·8	5·0	4·5
20—25	—	—	—	—	—	—	—	*3*	*5*	—	*5*	*30*	*3*	*2*	*5*	*10*
	—	—	—	—	—	—	—	5·1	2·5	—	6·2	5·4	3·5	7·2	8·7	5·6
25—30	—	—	*1*	—	—	—	—	*15*	*1*	—	*15*	*12*	*3*	—	—	*2*
	—	—	1·0	—	—	—	—	8·4	1·5	—	7·8	7·0	13·7	—	—	9·2
30—35	—	—	*9*	—	—	*1*	*1*	*11*	*1*	—	*2*	*1*	—	—	—	—
	—	—	6·0	—	—	12·5	0·8	14·6	9·1	—	18·2	16·0	—	—	—	—
35—40	—	—	*10*	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	12·1	—	—	—	—	—	—	—	—	—	—	—	—	—
40—45	—	—	*2*	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	15·8	—	—	—	—	—	—	—	—	—	—	—	—	—
55—60	—	—	—	—	*1*	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	2·5	—	—	—	—	—	—	—	—	—	—	—

Ordinary figures: Mean of Observations; Italic figures: Numbers of Observations

Discussion.

Five methods have been used in testing the reliability of survey. They combine to show that echo-survey is a useful way of finding fish over wide areas.

There are three weaknesses to the method:—

(1) Identification of the fish. At full speed, it is impossible to use those criteria for identification that Hodgson (1950) has used. His methods were usually applied when the ship was stopped. However, sprats can nearly always be identified in shallow water, when the ship is steaming at full speed, by their "comet" appearance on the paper (Hodgson 1950). Richardson (in the press) has been able to distinguish sprats from herring in the Southern Bight, using this feature. He found a patch of sprats off the Dutch coast that was subsequently confirmed by Dutch fishery landings. This is an outstanding case of successful identification in survey on the appearance of the trace alone. This is, however, an exception, and identification on survey must rely on fish landings, and egg and food distributions.

Hodgson's identifications with the sounder must depend on a complex of factors. These will include the following:—

(a) Shoaling distribution, i.e., the density of fish within shoals, and the vertical and horizontal extent of the shoals.

(b) Size of the fish. The significant dimension is the lateral cross-sectional area, the greatest area that is likely to be in the path of the sound wave.

(c) Reflectivity of the fish material. There are two factors to be considered here — the shape of the fish in vertical cross-section and the added effect of the air bladder. The air bladder contributes a far greater share to the reflectivity of the fish than one would expect from its cross-sectional area.

The relation between these three factors is quite unknown and so, until they become clear, additional forms of identification must be used.

(2) Sampling error. There are three types of variance that may contribute to sampling error for one species of fish:—

(a) Number of shoals per unit volume of sea.

(b) Shoaling density, i.e., the number of individuals per unit volume of sea, within each shoal.

(c) The effect of depth. There are three effects that change with depth:—

i. The received signal from fish decreases with depth according to the inverse square law.

ii. The received signal from fish decreases with depth due to attenuation; this effect is small in shallow waters, like those of the North Sea and English Channel.

iii. As the sound beam goes deeper, the area of the base of the "cone of sound" becomes greater and so the chance of sounding on fish becomes greater.

The combination of these effects may be expressed in a polar diagram; from this a probable number of fish from a particular signal may be inferred, so long as identification has been made.

(3) Spawning and feeding shoals differ in two ways:—

(a) The air bladder may be compressed by the gonads and the fat content of the fish may be different. Thus the relative values of air bladder to total fish volume may change between feeding and spawning.

(b) The shoaling distribution is probably different. Spawning fish occur in large shoals, whereas feeding fish occur in small ones.

These weaknesses can probably be dealt with.

There are two main directions in which the method of echo-survey may be employed:—

(a) Survey of pelagic fisheries and their possible extension. From this comes the possibility of studying migrations; during April, May, and June 1949, I have been able to distinguish 3 patches of herring that move together. Their migration makes a consistent picture over a period of two-and-a-half months.

(b) Estimating quantities of pelagic fish. This has not been tested yet.

References.

Balls, R., 1948. "Herring fishing with the echometer." J. du Conseil, **15**, 2, pp. 193—206.

Hardy, A. C., 1924. "The Herring in relation to its Animate Environment. Part I. The food and feeding habits of the herring with special reference to the East Coast of England." M. A. F., Fish. Invest., II, **7**, No. 3.

Hodgson, W. C., 1950. "Echo-sounding and the pelagic fisheries." M. A. F., Fish. Invest., II, **17**, No. 4.

Richardson, I. D. (In the press).

Runnström, S., 1941. "Quantitative investigations on herring spawning and its yearly fluctuations at the west coast of Norway." Fiskeridirekt. Skr., Ser. Havunders., **6**, No. 8, pp. 40—48.

Renou, J., & Tchernia, P., 1947. "Détection des bancs de poissons par ultrasons." Ministère de la Marine, Paris.

Savage, R. E., 1931. "The relation between the feeding of the herring off the east coast of England and the plankton of the surrounding waters." M. A. F., Fish. Invest., II, **12**, No. 3.

Tester, A. L., 1943. "Use of the echo-sounder to locate herring in British Columbia waters." Fish. Res. Board of Canada, Bulletin No. 63.

The Use of Transformations in Marine Biological Statistics.

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Introduction. One of the major difficulties the marine biologist encounters in the application of sound statistical methods to the results of his various sampling techniques is the fact that the assumptions under which the usual tests of significance are valid are often not fulfilled when his raw data are used directly. This is true whether he be counting fish, plankton, or bottom fauna. Therefore, although in his "field" work he is at the present time rarely dealing with the complicated experimental situations common now in genetical and agricultural science, his particular difficulties are often either not mentioned or only given scanty attention in the text-books to which he turns for assistance; indeed they are often not dealt with adequately except in comparatively recent statistical papers. The problem must be faced, and in general enough work has now been done to indicate the type of adjustment which should be made before proceeding to analyse such data. In the following, an attempt is made to summarize the work on this problem, with illustrations taken from marine biology; familiarity with the more usual statistical methods and terminology will be assumed.

The Conditions necessary for an Analysis. The difficulties can be best appreciated by considering the main assumptions regarding the nature of the observations that are necessary before, say, an analysis of variance can be considered valid (C o c h r a n, 1947). These may be summarized:—

1. The experimental errors are normally distributed.
2. The experimental errors have a common variance, or, where these errors can be split up and assigned to separate parts of an experiment or investigation, then the error assignable to each part has a common variance.
3. The various effects under consideration are additive so that each contributes a constant increment to an observation; differences

between group means then indicate such effects.

4. The experimental errors are all independent; the probability that the error of any observation has a particular value should not depend on the error of the other observations.

The failure of some of these assumptions in marine sampling has already been noted by a number of workers in several different types of investigations. Thus Silliman (1946) took samples of pilchard eggs at a large number of stations in the Pacific and the frequency distribution of his catches is given in Figure 1a. Clearly the distribution of the

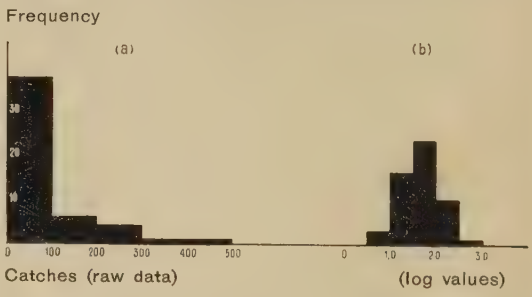

Figure 1. Frequency distribution of catches of pilchard eggs from data by Silliman: (a) distribution for raw data; (b) distribution for log values of catches.

catches is far from normal and it was appreciated by Silliman that it would be unsound to apply an analysis of variance to these results without first adjusting the raw data. The dependence of the variability upon the size of catch in a series of plankton hauls was pointed out by Winsor and Clarke (1940) who examined such hauls for several species of copepods. The following table (taken from their results) in which the variability is indicated by the range in the counts illustrates this dependence of variability upon mean.

Table 1.

	Species 1	Species 2	Species 3	Species 4
Mean	671	1,701	30,775	9,396
Range	663	1,480	24,400	9,440

The same feature was also found in counts of several species of fish taken in replicate hauls with a V. D. Trawl (Barnes and Bagenal, 1951). The proportional change produced by a "treatment" in contrast to the required additive effect can be seen in the catches obtained by Künne, (1933) in his comparison of vertical hauls with a Hensen and Heligoland egg-net. Two sets of results selected from his data are shown in Table 2.

Clearly, and indeed as might be expected, the catches of the two nets are roughly in constant proportion, the Net 1 catching about 3—4 times that of Net 2 in the paired samples. The additive character of the "treatment" effects requisite for an analysis of variance is not fulfilled, and some adjustment to the raw data is necessary.

In practice some of the above assumptions often fail together; for example, in non-normal distributions (failure of 1 above) there is

Table 2.

Species	Medusae	Terebellids	*Tomopteris*	*Calanus*	Decapods
Station I.					
Net 1	1,486	21	229	947	1,001
Net 2	422	9	59	140	327
Ratio ½	3·52	2·33	3·88	6·76	3·06
Station II.					
Net 1	1,399	30	153	744	489
Net 2	424	8	29	169	165
Ratio ½	3·30	3·75	5·28	4·40	2·96

usually a correlation between the variance and the mean so that assumption 2 also fails. The early work concerning the effect of non-normality on tests of significance has been summarized by Hey (1938) and the consensus of opinion (Bartlett, 1935; Pearson, 1931) has been that moderate departures from normality do not introduce gross errors in the significance levels of the F-test (see also Geary, 1947): in general there is a tendency to err in the direction of giving too many significant results. Non-normality is also likely to impair the efficiency (roughly measured by the variance between estimated and true values) in the estimation of "effects" and to result in a loss of power (lack of sensitivity in determining real differences) in the F- and *t*-tests. The results are not likely to be serious with only small departures from normality, but bias may arise from pooled errors.

The Function of a Transformation. In the type of data under consideration in marine sampling, departure from normality is, however, often very marked and analysis of the raw data therefore leads to considerable errors and incorrect conclusions. In order to avoid these difficulties a transformation is applied to the raw data, so that they are, so to speak, transferred to a new scale. In the ideal case the transformation should fulfil the following conditions (Bartlett, 1947):—

(i) The variance of the transformed variate should be unaffected by changes in the mean level.

(ii) The transformed variate should be normally distributed.

(iii) The transformed scale should be one for which an arithmetic mean gives an efficient estimate of the true mean level for any particular group of measurements.

(iv) The transformed scale should be one for which real effects are both linear and additive.

It is not always possible to satisfy all these conditions by a single transformation, but the above requirements are to some extent mutually dependent. It is important to satisfy (i) and (ii) if F- and *t*-tests are to be made, and usually, a transformation which fulfils the first condition, that is, stabilizes the variance, improves the closeness of the distribution to normality. (See Bartlett for further discussion.)

If the form of the frequency distribution of the variate is known it enables an appropriate transformation to stabilize the variance to be selected on a theoretical basis. In marine sampling this frequency distribution is usually Poisson or some form of contagious distribution such as the negative binomial, and in the light of previous work, satisfactory transformations can usually be applied.

The Square Root Transformation. If the variate has a random (Poisson) distribution then the variance of the distribution is equal to the mean, and the appropriate adjustment of the variate is by some form of square root transformation. Such a transformation was first suggested by Bartlett (1936), who also pointed out that if the mean were small and there were some zero observations a better transformation than the square root, although somewhat less convenient, was $\sqrt{x+0{\cdot}5}$. For the square root transformation the expected variance is roughly 0·25 if the mean is large, and roughly so with $\sqrt{x+0{\cdot}5}$ even if the mean is not large. Anscombe (1947) has recently pointed out that a better transformation for a Poisson variable is $\sqrt{x+3/8}$, which gives a more nearly constant variance of 0·25.

In sub-samples made in the laboratory the variable usually has a Poisson distribution and one of the above transformations can be confidently applied to most of such work, when the practical technique has been adequately controlled. Indeed, tests on sub-samples of this kind are usually made to determine whether the laboratory sampling technique has been adequate, a Poisson distribution being assumed to hold from the very nature of the sampling. As illustration the following results may be quoted. Gardiner (1931) took 25 samples from a well-stirred mixed plankton sample and counted four organisms in each sample. After each withdrawal the sample was counted and replaced in the original suspension before withdrawing the next sample. The means and variances on the several scales are shown in Table 3; the increase of variance with mean is clearly seen, as well as the effect of the transformations, between which there is little to choose, in stabilizing the variance. (The differences in these three types of square root transformation are noticeable only when the mean is less than ten).

It must be emphasized that whilst the above transformations are adequate when comparing the sub-samples from a primary sample,

Table 3.

Species		*Paracalanus*	*Temora*	Others
Number (x)	Mean	55·1	12·4	16·6
	Variance	56·94	12·42	16·17
$\sqrt{x}$	Mean	7·40	3·49	4·05
	Variance	0·271	0·250	0·215
$\sqrt{x+0{\cdot}5}$	Mean	7·44	3·56	4·11
	Variance	0·268	0·240	0·207
$\sqrt{x+3/8}$	Mean	7·43	3·54	4·10
	Variance	0·268	0·244	0·209

they may not be, and indeed usually are not, adequate for comparisons of the primary samples themselves. However, if the population density over the area studied is low, the distribution is often a close approach to Poisson and the square root transformation may still be applied. This may be illustrated by the following unpublished results.

A number of plankton samples were taken in the Clyde by means of a modified Hardy Plankton Recorder, some during the day and some the following night. The object of the investigation was to study the distribution of the various planktonic species and to determine whether there had been any population changes over the period. Each sample was taken over two miles and contained the plankton from about 600 litres; Table 4 gives the means and variances of the catches, before and after the application of a number of transformations, for two of the species whose population density was very low.

Table 4.

Species		*Podon* sp.	Polychaeta
Number (x)	Mean	1·19	2·75
	Variance	2·03	3·13
$\sqrt{x+0{\cdot}5}$	Mean	1·20	1·73
	Variance	0·27	0·29
$\sqrt{x+3/8}$	Mean	1·13	1·68
	Variance	0·30	0·31

The stabilization of the variance has again clearly been effected almost equally well by both the transformations and the appropriate tests of significance can be applied to the results. After the appropriate transformation it was possible to show that in many of the species there was no significant difference between the day and the night means, that is to say, the population at the 10 metre level sampled by the Recorder could be considered constant. Such constancy of population has often previously been assumed, for example in experiments to study vertical migration, but has rarely been demonstrated over a given large area.

The Logarithmic Transformation. In the previous transformation for a random Poisson variable, the variance is equal to the mean; more frequently in marine sampling the square root of the variance, that is, the standard deviation, is roughly proportional to the mean. The correct transformation is then to the logarithm of the variate. When zeros occur the logarithm of 1 plus the observation should be used. For example, if the results already quoted from Winsor and Clarke are transformed to a logarithmic scale they become:—

Table 5.

Species	1	2	3	4
Mean	2·80	3·22	4·48	3·96
Range	0·43	0·39	0·36	0·41

A plot of the means and variances from a series of samples taken from the Clyde survey just quoted is shown in Figure 2, and illustrates the case where the standard deviation rather than the variance is roughly proportional to the mean. Table 6 gives the means and variances of the catches, before and after applying the logarithmic transformation, and the effect of the latter in stabilizing the variance is clearly shown.

Table 6.

Species		*Centropages* ♂	*Temora* ♀	*Calanus* ♀	*Oikopleura*
Number (x)	Mean	2·44	5·88	14·56	20·75
	Variance	6·26	17·98	327·38	238·87
log (x+1)	Mean	0·42	0·72	0·95	1·23
	Variance	0·12	0·14	0·22	0·11

The Hyperbolic Transformation. When the standard deviation increases roughly linearly with the mean, but the relation is strictly of the form shown in Figure 3, that is, for a mean of less than 1 the variance is roughly proportional to the mean whilst for a mean greater than 1 the standard deviation is proportional to the mean, then a transformation of the variate to $1/\beta \cdot \sinh^{-1} \beta \sqrt{x}$ (where β is the slope of the line giving the dependence of standard deviation upon the mean) may be better than the logarithmic transformation (Quenouille, 1950).

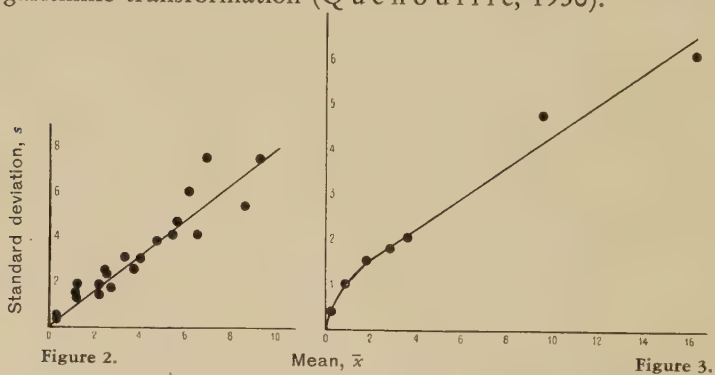

Figure 2. Figure 3.

Figure 2. Plot of standard deviation against mean for plankton catches taken by modified Hardy Plankton Recorder in the Firth of Clyde.

Figure 3. Plot of standard deviation against mean for selected series of samples taken by pump in investigation in the Clyde.

A set of results from Barnes and Bagenal (1951) obtained in investigating the variability of replicate trawls over an inshore ground is given in Table 7.

There is not a great deal to choose between the logarithmic and hyperbolic transformation with these data, or between the more complicated $1/\beta \cdot \sinh^{-1} \beta \sqrt{x}$ and $\sinh^{-1} \sqrt{x}$ transformations.

Normally unless many small observations are taken and unless there is a clear indication that the above type of transformation is required,

it is easier and almost as good to use the log $(x+1)$ or $\sinh^{-1}\sqrt{x}$, that is, seetting $\beta = 1$.

The Normalizing Effect of the Transformation. Fortunately, if the distribution does not deviate greatly from normality, transformations which stabilize the variance also tend to normalize the distribution. Both the logarithmic and the square root transformations tend to correct

Table 7.

Samples		1	2	3	4
Raw (x)	Mean	11·3	21·3	42·5	115·3
	Variance	22·3	190	408	2457
$\sqrt{x}$	Mean	3·31	4·44	6·34	10·57
log x	Variance	0·442	1·99	3·09	4·66
log x	Mean	1·03	1·27	1·58	2·04
	Variance	0·029	0·068	0·075	0·027
$\sinh^{-1}\sqrt{x}$	Mean	1·90	2·17	2·51	3·03
	Variance	0·034	0·088	0·097	0·034
$1/\beta \cdot \sinh^{-1}\beta\sqrt{x}$	Mean	2·72	3·30	4·09	5·34
	Variance	0·150	0·435	0·524	0·212

skewness in any set of positive observations, the square root being the less drastic transformation. The effect of the logarithmic transformation is clearly shown in Figure 1 (b), which gives the histogram for the logarithmic values of S i l l i m a n' s data.

The Additive Character. The logarithmic transformation is important when a proportional change occurs, since after the transformation to logarithms such a change becomes additive. Thus in K ü n n e' s data already quoted (pp. 62/3) the factor 3—4 by which the catches differ becomes the addition of log 3—4 when the transformed variate is used.

The Relations of the above Transformations. If, as in much of this work, the variance of a series of observations is greater than the mean, it suggests that the mean level itself is fluctuating, and that the variance law is of the type:—

$$\sigma_r^2 = m + \sigma_m^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where m is the mean and σ_m^2 its variance. In many biological populations, increase in numbers is often proportional to the numbers already present and this gives rise to variations in the mean from sample to sample, such variations being themselves proportional to the mean (see, for example, B e a l l, 1942). The variance law then becomes:—

$$\sigma_r^2 = m + \beta^2 m^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Curves showing dependence of variance on mean on the assumption of a variance law of the type given by equation (2) are given in Figure 4 for a series of values of m and β^2 arbitrarily selected. It is clear that as β^2 approaches 0, the dependence becomes that of a Poisson variable.

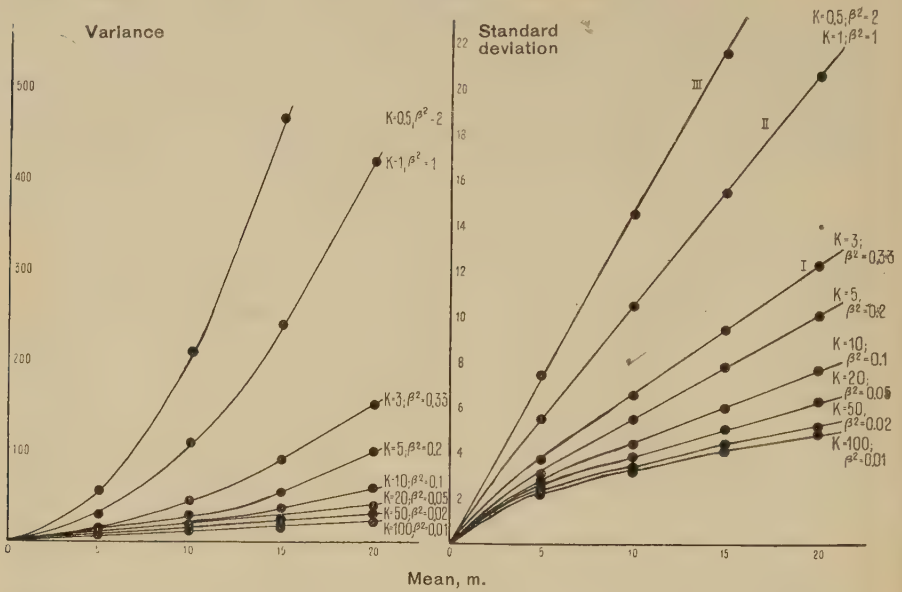

Figure 4. Curves showing dependence of variance on mean on assumption of equation (2) for selected values of mean (m) and constant β^2 ($= \frac{1}{k}$): see p. 69.

Figure 5. Curves showing dependence of standard deviation on mean on assumption of equation (2) for selected values of mean (m) and constant β^2 ($= \frac{1}{k}$).

In Figure 5 the mean and the standard deviation are plotted for the same values; with β small the Poisson type of dependence is approached, while for intermediate values, a curve similar to that given in Figure 3 is obtained, and in this region the hyperbolic transformation is required. With β large the dependence is virtually linear and the logarithmic transformation may be used.

If certain assumptions are made about the distribution of the individuals being sampled, then it can be shown that equation (2) is an expression for the variance of a negative binomial distribution. A model giving rise to such a distribution and likely to apply to marine work when the variance is greater than the mean is one in which animals are aggregated into groups. If such groups are randomly distributed so that the number of groups in a sample of fixed area has a random (Poisson) distribution, then, if numbers of individuals in the groups are distributed independently in a logarithmic distribution, a negative binomial results. An alternative model is that of heterogeneous Poisson sampling; if the mean λ of a Poisson distribution varies randomly from occasion to occasion, a negative binomial with exponent k is obtained if λ has a Pearson Type III distribution. The exact sampling theory of the negative binomial has recently been given by Anscombe (1949, 1950), and it would seem that a negative binomial or some other form of contagious distribution such as Neyman's or Thomas's distributions is very often applicable to plankton counts (Barnes and Marshall, 1951).

The variance of a negative binomial, with mean m and exponent k, is usually given in the form of:—

$$\sigma^2 = m + m^2/k \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

so that k is the inverse of the constant β^2 in equation (2). If such an assumption of a negative binomial is made then $1/k$ can be estimated, even when there are insufficient values for plotting. The methods of estimating k which are efficient under varying circumstances (for different values of k and m) have now been given by Anscombe (1949).

When k has been estimated, then the appropriate transformation may be applied to stabilize the variance. If k is not less than 2, the correct transformation is to,

$$y = \sinh^{-1} \sqrt{\frac{x + c}{k - 2c}}$$

where c is a constant of 0·375. When k has a large value the expected variance is roughly $1/(k—1/2)$. This is a more exact transformation equivalent to $1/\beta \sinh^{-1} \beta \sqrt{x}$. If k is between 2 and 5 a simpler transformation is:—

$$y = \log_{10} (x+\tfrac{1}{2}k)$$

(This is equivalent to setting $c = \frac{1}{2}k$ in the previous transformation.) Clearly this transformation is a more exact equivalent for a negative binomial to the logarithmic transformation and could be applied to the upper curves of Figure 5. These transformations have been applied to the data given in Table 7 and also to some plankton counts (Figure 3) in Barnes and Marshall (1951).

Table 8.

Samples		1	2	3	4
Raw	Mean	1·76	3·65	9·60	16·30
	Variance	2·38	4·25	22·66	37·76
$\log (x+\frac{1}{2}k)$*	Mean	0·78	0·90	1·13	1·30
	Variance	0·0098	0·0122	0·0184	0·0175
$\sinh^{-1} \sqrt{\frac{x+c}{k-2c}}$	Mean	0·46	0·63	0·93	1·13
	Variance	0·026	0·025	0·028	0·024
$\log (x+\frac{1}{2}k)$	Mean	1·12	1·33	1·61	2·05
	Variance	0·019	0·054	0·065	0·026
$\sinh^{-1} \sqrt{\frac{x+c}{k-2c}}$	Mean	1·26	1·50	1·82	2·31
	Variance	0·027	0·071	0·086	0·050

* k estimated (not taken from graph) = 9 and 5, c = 0·375.

The Use of the Transformed Data. Analysis, comparison of means, and significance tests should be performed on the transformed data. However, it is often required to transform the results back to the original

scale for interpretation and for comparison with other raw data. If comparisons are to be made, fiducial limits should be set first on the transformed values, and these when transformed back to the original scale give the limits for the derived means. However, in order to make the derived means comparable with the values obtained by straight averaging, but not liable to great distortion by one or two extreme values, it is necessary to make small adjustments, the form of adjustment depending on the transformation. For either of the logarithmic transformations 1·15 times the variance should be added to the transformed mean before transforming back again; for the square root transformations the variance of the transformed observations should be added to the derived means after transforming back. The logarithmic mean after this adjustment is transformed back by subtracting 1 from the antilog, whilst with the square root transformation the means are squared and the adjustment added.

Summary. The distribution of the sample values obtained in many types of investigation, when the variable is a count, is frequently such as to render analysis of the raw data invalid. The data have to be transformed to a new scale.

The conditions required for a valid analysis and for a satisfactory transformation are briefly considered.

With much field work, a logarithmic transformation would often seem adequate, but other transformations are also considered. These more accurate transformations might well be considered when the data are from carefully organized experiments such as the comparison of different kinds of sampling devices (nets, trawls).

The relation of these transformations to the negative binomial distribution and its more accurate sampling theories is then discussed.

I wish to express my gratitude to Mr. F. J. Anscombe for his critical comments and valuable advice on this paper.

References.

Anscombe, F. J. 1948. "The transformation of Poisson, Binomial and Negative-Binomial data." Biometrika, Vol. 35, pp. 246—254.

— 1949. "The statistical analysis of insect counts based on the negative binomial distribution." Biometrics, Vol. 5, pp. 165—173.

— 1950. "Sampling theory of the negative binomial and logarithmic series distributions." Biometrika, Vol. 37, pp. 358—382.

Barnes, H., & Bagenal, T. B. 1951. "A statistical study of variability in catch obtained by short repeated trawls taken over an inshore ground." Journ. Mar. Biol. Assoc., Vol. 29, pp. 649—660.

Barnes, H., & Marshall, S. M. 1951. "On the variability of replicate plankton samples and some application of 'contagious' series to the statistical distribution of catches over restricted periods." Journ. Mar. Biol. Assoc., (in the press).

Bartlett, M. S. 1935. "The effect of non-normality on the t-distribution." Proc. Camb. Phil. Soc., Vol. 31, pp. 223—231.

— 1936. "The square root transformation in the analysis of variance." J. R. Statis. Soc. Suppl., Vol. 3, pp. 68—78.

— 1947. "The use of transformations." Biometrics, Vol. 3, pp. 39—53.

Beall, G. 1942. "The transformation of data from entomological field experiments so that the analysis of variance becomes applicable." Biometrika, Vol. 32, pp. 243—262.

Cochran, W. G. 1947. "Some consequences when the assumptions for the analysis of variance are not satisfied." Biometrics, Vol. 3, pp. 22—38.

Gardiner, A. C. 1931. "The validity of single vertical hauls of the international net in the study of the distribution of plankton." Journ. Mar. Biol. Assoc., Vol. 17, pp. 449—472.

Geary, R. C. 1948. "Testing for normality." Biometrika, Vol. 34, pp. 209—242.

Hey, G. B. 1938. "A new method of experimental sampling illustrated on certain non-normal populations." Biometrika, Vol. 30, pp. 68—80.

Künne, Cl. 1933. "Weitere Untersuchungen zum Vergleich der Fangfähigkeit verschiedener Modelle von vertikal fischenden Plankton-Netzen." Rapp. et Proc.-Verb., Cons. Int. Explor.Mer, Vol. 83, pp. 1—36.

Pearson, E. S. 1931. "The analysis of variance in case of non-normal variation." Biometrika, Vol. 23, pp. 114—133.

Quenouille, M. H. 1950. "Introductory Statistics." London.

Silliman, R. P. 1946. "A study of variability in plankton townet catches of Pacific pilchard *Sardinops caerulea* eggs." Journ. Mar. Res., Vol. 6, No. 1, pp. 74—83.

Winsor, C. P., & Clarke, G. L. 1940. "A statistical study of variation in the catch of plankton nets." Journ. Mar. Res., Vol. 3, pp. 1—34.

Note.

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CONTRIBUTORS are regretfully informed that in consequence of the present financial stringency, it has been found necessary to place a limit of 20 copies on the number of free offprints of articles that can be supplied to authors. The number of separate reprints that can be provided at the author's expense is likewise limited to 200. (Copies, up to this number, should be ordered at or before the time the proofs are returned to Copenhagen.) No offprints of reviews are provided.

This applies not only to the Journal, but to all the Council's publications.

Letters to the Editor.

Winds and Brood Strengths.

Lowestoft, 18th July 1951.

Dear Sir,

In their paper (*Kieler Meeresforschungen*, **8**, No. 1, 1951) Carruthers, Lawford, and Veley cite me in support of one of their suggestions and as supplying certain data. This may suggest that I agree with their general approach and conclusions, which is far from being the case.

Yours faithfully,

A. C. Simpson.

Lowestoft, 28th July 1951.

Dear Sir,

It seems very unlikely that the suggestion of Carruthers, Lawford, and Veley (*Kieler Meeresforschungen*, **8**, 1, Part III), is within the bounds of possibility. The suggestion is that the success or failure of broods of cod in the North Sea depends on whether the fry are drifted into the Great Northern Eddy, or whether, missing this, the fry are carried into an area towards the Norwegian coast, and so become lost to the North Sea fishery.

The area of the northern eddy is rather far removed from the main cod nurseries, which lie south and east of the Dogger Bank (Graham, Fish. Invest., II, XIII, 4, 1934, p. 70).

The supposedly critical drift of fry bears no relation to that actually traced by Hensen and Apstein (Wiss. Meeresunters. Kiel II, 2, 1897, Taf. V—VII), nor to the similar history followed by Graham, Carruthers, and Goodchild (Fish. Invest. II, VIII, 6, 1926, chart 8, etc.).

Moreover, study of Figure 15 of Carruthers *et al.*, loc. cit. reveals that in many of the "good" years, when their *point* representing the fry falls within the area of the eddy, most of the fry would not do so. Indeed, these authors' explanation involves the corollary that the success or failure of brood depends mainly on the fate of the fry from only one of the four main spawning areas, the Ling Bank. There is no evidence that spawning on the Ling Bank is greater than that in the other areas; so, we are faced by a *reductio ad absurdum*.

Yours truly,

Michael Graham.

Reviews.

A. F. Bruun. "Scientific Results of the Danish Expedition to the Coasts of Tropical West Africa 1945—46." Atlantide-Report, No. 1, 247 pp., 86 figs. Published on behalf of the University of Copenhagen, and the British Museum (Natural History), London. Danish Science Press, Ltd., Copenhagen, 1950.

The above-named expedition was made possible by the generosity of the Danish sculptor, Mr. Viggo Jarl, who placed his 3-masted auxiliary motor yacht "Atlantide" at the disposal of the University of Copenhagen, together with a round sum for the equipment of the ship. Later on, cooperation with the British Museum (N. H.) was established, leading to the participation of Dr. F. C. Fraser in the expedition. The scientific leader was Dr. A. F. Bruun, with Mr. Jørgen Knudsen, M. Sc., and Mr. Torben Wolff, B. Sc., as assistants.

After a short foreword by Prof. R. Spärck, Dr. Bruun gives a general description of the equipment, fishing gear, and itinerary of the expedition. During the period 3. October 1945 to 17. June 1946 the "Atlantide" covered more than 13,000 miles from Portsmouth via the Canary and Cap Verde Islands along the West African coast from Dakar to Loanda (Angola) and back; 170 stations were worked in the course of the voyage.

In two papers ("Two Skulls of *Globicephala macrorhyncha* (Gray) from Dakar" and "Description of a Dolphin *Stenella frontalis* (Cuvier) from the coast of French Equatorial Africa") F. C. Fraser describes two different species of dolphins. In the first paper he discusses the relationship between the several species of *Globicephala* hitherto described; from a large material of measurements, he comes to the conclusion that two skulls, remains of a school of 151 pilot whales which had stranded not far from Dakar in 1943, belong to the species *Globicephala macrorhyncha*. In the second paper he gives a detailed description of a dolphin harpooned from the ship, concluding that it must be ascribed to the little known species *Stenella frontalis*.

Jørgen Knudsen ("Egg Capsules and Development of some Marine Prosobranchs from Tropical West Africa") collected, and in this paper describes, egg capsules of 35 species of prosobranchs. He emphasizes the curious fact that of these 35 species 22, or 69 %, had a non-pelagic development; this is in contrast to what has been found in other tropical areas and corresponds to the percentage found in the waters south and west of Iceland. The author, after having admitted that the material at hand (32 species out of about 600) is possibly too small to be representative, discusses two

characteristic features of the Guinea Current who might favour a non-pelagic development among the prosobranchs, viz., the strong exchange of water between the coastal and oceanic waters over the narrow continental shelf and the poverty of the Guinea Current in nutrient salts. An investigation of a much larger number of species is needed, however, to solve the interesting question of a possible dominance of non-pelagic development among the prosobranchs in this area.

Torben Wolff gives an account of "Birds collected by the Atlantide-Expedition to West Africa 1945—46". The collection numbers 100 specimens, covering 58 species and subspecies.

In a paper entitled "Geographical Variation of *Siphonaria pectinata* (L.)", Bengt Hubendick (Stockholm) deals with 17 samples of this prosobranch species from different localities, according to the methods of "the new systematics". Certain characters, e.g., length, breadth, diameter of the central area, the number of radii in the sculpture, etc. have been examined, and the author has found a very probable occurrence of a geographical variation based on genetic conditions.

F. Jensenius Madsen has treated the starfish of the expedition ("The Echinoderms collected by the Atlantide-Expedition 1945—46. I, Asteroidea. With remarks on other sea-stars from tropical and northern West Africa"). 40 species and subspecies are enumerated and described in detail; the author establishes 2 new species *(Astropecten spiniphorus* and *Luidia atlantidea)* and 1 new subspecies *(Astropecten michaelseni* var. *ambiguus).*

The last paper in this volume is by *L. Harrison Matthews* ("The male urogenital tract in *Stenella frontalis* (G. Cuvier)"). It gives a description of the urogenital tract including the kidneys and ureters of the animal captured by the expedition.

Although the Atlantide-Expedition, as Dr. Bruun says in his General Report, had to cut down its original plan which included visiting Capetown, St. Helena, and Ascension, it may be said that the expedition brought home a larger material from the little known coastal region of West Africa than any other earlier expedition.

H. Blegvad †.

G. Neumann. "Gibt es eine 'Kritische Windgeschwindigkeit' für die Grenzfläche Wasser-Luft?" Deutsche Hydrogr. Zeitschr. Bd. **4**, H. 1/2, S. 6—13. Hamburg, 1951.

In this paper Neumann examines the data given by Munk (1947), who states that there is a critical wind speed (about 6·5 m./sec.) above which the drag of the wind on the sea varies as V^2 (V = wind speed) and below which the sea is aerodynamically smooth; he also examines the descrepancy between measurements of stress made on the one hand from observations of the wind-induced tilt to leeward of lakes and bays and on the other from observations of the variation with height of the wind velocity in the lowest 10 metres of the atmosphere; he compares the results of Roll (1948), who measured wind profiles over the open sea, with those of Motzfeld (1937), who measured air-flow over solid, stationary models of waves in a wind tunnel; finally he re-affirms his earlier conclusion that drag varies as $V^{3/2}$ at wind speeds above about 1 m./sec.

Although it is not entirely clear that Motzfeld's work is relevant to the problem, Neumann is right in saying that there are difficulties in applying the wind gradient technique; the form of the profile is not yet clearly

established even in conditions of neutral equilibrium and the relation between the stress and the wind profile is complicated by the difficulty of choosing a datum for height and for velocity. Neumann does not mention the difficulty of measuring tilt (as distinct from seiche) at low wind speeds but the measurements he plots — a complete set so far as one can see — are extremely systematic, much more so than the estimates made by the wind-profile technique.

There is, however, a third technique by which the drag can be determined from measurements of the variation of wind with height in the friction layer. Neumann ignores values obtained independently by Rossby (Pap. Phys. Oceanogr. & Meteor. **4**, 3, 1936) based on pilot balloon ascents of the Deutsche Seewarte, by Sutcliffe (Quart. Journ. Roy. Met. Soc. **62**, 3, 1939) based on kite ascents made on the "Meteor" expedition, and by Durst (Monthly Not., Roy. Astronom. Soc., Geophys. Suppl. **5**, p. 270, 1949), all of which agree that the drag at low wind speeds is much less than that predicted by Neumann's expression. The variation of drag with wind is not clear but there is some indication that drag varies as V^3. This latter conclusion agrees with that reached by Francis (Proc. Roy. Soc., A 206, p. 387, 1951) from a study of wind-generated waves in a laboratory tank. This work seems more realistic than that of Motzfeld and should be compared with that of Keulegan (Journ. Res. Nat. Bur. Standards, **46**, 5, p. 358, 1951).

Results obtained by all three techniques were discussed in a review article by Charnock (Sci. Progr., 153, p. 80, 1951). There are obvious discrepancies especially at low wind speeds but the problem has been clarified (though not solved) by measurements by all three techniques as part of a general research into the transfer of energy from the atmosphere to the ocean. It is hoped that details will be published later. It becomes increasingly clear that the drag of the wind on the sea is perhaps the most important central problem confronting meteorologists and oceanographers.

H. C.

K. F. Wiborg. "The Whirling Vessel. An apparatus for the fractioning of plankton samples". Fiskeridirek. Skr., Ser. Havunders., **9**, 13, pp. 1—16, 3 figs. Bergen, 1951.

Lea and Rollefsen designed this subsampler in 1930; Wiborg has made some improvements to it and has carried out some tests on its sampling efficiency.

It is a cylinder, open at one end and suspended by a string from its axis. The cylinder is divided radially into ten compartments. When it is to be used, it is half-filled with water and the plankton sample is added; it is spun rapidly by hand and then sharply stopped. This is to ensure an "even" distribution of the plankton. When it has settled it can be drained off from the required compartment by a tap from below.

The tests were carried out in the following way. An artificial sample (of 1,000 cod eggs, 1,000 *Calanus finmarchicus*, and 100 larvae of *Sebastes marinus*) was subsampled ten times and the number in each of the compartments was counted. The test is used to compare the subsample observations with the expected values (the means of the observations were used). Table 3 shows three things:— (1) A total estimate of χ^2 is given for the replicates in each compartment; of these 9 out of 40 ($P=0{\cdot}05$) depart significantly from the expected, which is the mean of the replicates. (2) The mean of

the replicates in each compartment is compared with the grand mean for the whole experiment; of these 6 out of 40 ($P=0{\cdot}05$) depart significantly from the expected. (3) The latter estimate of χ^2 which is a pooled one, is subtracted from the former to give a measure of heterogeneity or interaction between the replicate means and the means of the compartments; this is significant in three cases out of 40. 20 % of the comparisons (excluding the observations on added subsamples, e.g., cod eggs and fish larvae and *Calanus*, and excluding the interaction results) depart significantly from the expected. The χ^2 values for 43 out of the 120 results lie between $P = 0{\cdot}5$ and $P = 0{\cdot}999$; high values of χ^2, like those of the correlation coefficient, are unusual.

The purpose of subsampling is to reduce the labour of counting without increasing the error of sampling. Coefficients of variation of zooplankton sampling lie between 30 % and 120 %. Wiborg gives average percentage deviations of 8·3 % for cod eggs, 6·9 % for copepods, and 24·1 % for fish larvae. These are not coefficients of variation; as the standard deviation is somewhat larger than the mean deviation, the implication is that the error might be less than that of the sampling at sea. This is based on the assumption that the errors of subsampling are randomly distributed; if a non-random element, e.g., grouping, were introduced, the variance due to this would have to be added to the estimate of sampling variance. Wiborg put plankton animals in one compartment, spun the "Whirling Vessel", and then counted them; from three replicates, "the numbers found did not differ from what had been found in the ordinary experiments and this was regarded as a proof that the rotation of the vessel is sufficient to ensure an even distribution of the sample over all the compartments." This is not an adequate test of an "even", or random, distribution. It is firstly necessary to show that the results of these experiments demonstrate that there is or is not an effect of grouping; as the χ^2 tests show a rather high degree of departure from the expected, it is possible that the subsamples include a certain amount of aggregation into groups. It would perhaps be useful to test for grouping by finding the goodness of fit of a contagious distribution to a number of subsamples. Then it might be possible to use an appropriately transformed analysis of variance in order to estimate the components of variance in the system.

D. H. C.

Hans Lübbert. "Die grossen Seefischereien der Erde, ihre Fanggründe und ihre Fangprodukte." 5 + 104 S., 141 Tabl., 4 Karten. Girardet & Co., Hamburg, 1950.

This book gives a general survey of the great sea fisheries of the world, their fishing grounds and products. It is a compilation of available statistics but contains also valuable accounts of the author's personal knowledge and experiences of the world fisheries. The author was for many years Director of Fisheries at Hamburg and has paid several visits to a number of different countries in order to study or organize their fisheries. He is also known as one of the editors of the great handbook of sea fisheries of north-western Europe. The paper was ready in May 1944, but not printed before May 1950. The author points out the difficulty of getting statistics for corresponding periods: on that account, the figures given are not quite comparable with each other.

After some remarks on the production of the different regions of the

oceans, an extract follows of the *Bulletin Statistique* of the I. C. E. S. for 1937 — though later data are published, the latest volume being for 1948. The next chapter furnishes descriptions of the fisheries of European Russia — the Caspian, Aral, and Black Seas and some of the rivers entering them. Notes concerning the fish and fisheries and the ecological conditions of the waters are based mainly on reports published by Averintsev, Kevdin, and Knipovich, and refer to the year 1926 or earlier years. This chapter contains also some information about the Soviet fishery carried out from Murmansk in 1938 and some figures relating to the fisheries in the Baltic and its Russian rivers. The statistics given for Spain are rather old, being for the year 1920, except a few figures for 1943. Later official Spanish data, published since 1940, are not taken into consideration. For Italy there is no complete official review of the fisheries, but a few data have been compiled. Some mean values for the fisheries of south-eastern Europe are also included.

The second part of the book presents rather detailed data regarding the yields of the great fisheries of Japan, China, and Asiatic Russia. It is of particular value, as information on these fisheries must be sought not only in official statistical reports but also in various special papers. There are data and descriptions concerning fish and shellfish, fishermen, vessels, fishing methods, fishing grounds, fish-conservation, and fish-markets. The authors quoted are mainly Averintsev, Barts, Baiersky, Berg, Classen, Peters, and Schepers. The most important fresh waters, their natural history and fisheries, are also treated. For China, many data are only estimated.

The third part of the book contains a detailed review of the fisheries of the U. S. A. and Canada, based mainly on the official statistical reports. The data with some exceptions relate to the year 1936. Some information on the yields of the fisheries of Newfoundland, St. Pierre and Miquelon is also given. The statistical figures presented refer to different years and mainly concern the export market.

After a fourth part containing a short description of the fisheries of the South African Union, a review follows of the world production of fish — according to the author's estimate, about 17,770 million kg. Statistical tables regarding the total catch of several countries are given, as well as figures concerning the production of some species of fish and fish products.

The final section of the paper discusses the possibilities of developing the present major fisheries and of establishing new ones. As a result of his great experience, the author's views are of special interest. Just before finishing his survey, the author received the "Year-book of Fisheries" of F. A. O. and a paper on the European post-war fisheries written by Meseck, but he could not take them into consideration without greatly delaying publication of his own work. He has, however, quoted some of Meseck's figures and suggestions in an addendum. The author does not expect any increase of the total landings in Europe but there will probably be an alteration in the market for fresh and salted fish. The prospects for the Murmansk fishery and the fishery in the Caspian Sea seem to be good. Regarding these prospective views it may be remarked that F. A. O. has lately started a world-wide research into the possibilities of developing the fisheries.

Nils Rosén.

A. C. Simpson. "The Fecundity of the Plaice." Min. Agric. & Fish., Fish. Invest., Ser. II, **12**, 5, 27 pp., 8 figs., 4 tables. London, 1951.

This paper is based on egg counts for 261 female plaice, all but 5 from the North Sea, mainly the Southern Bight (223 fish). Earlier data from Franz, Reibisch, and others are included in the discussion.

The relation between fecundity and gutted weight is found to be approximately linear, while fecundity is related to the cube of the length of the fish. Age, when separated from its influence on length, seems to play only an insignificant part in determining the fecundity of plaice.

Fecundity is most conveniently expressed by the formula $F = KL^3$, where K is a constant and L the length of body. The values for K are 1·48 for the Southern Bight area and 1·74 for the Flamborough area of the North Sea. The samples from the Southern Bight give the same K values in two consecutive years, suggesting that the higher fecundity in the Flamborough region is real. Older data from the south-eastern North Sea conform well to Simpson's findings.

It is most interesting that Simpson is able to confirm older data on the fecundity of the Baltic plaice population. For this, K varies mostly between 4 and 6 and there seems to be no doubt about the difference between the Baltic and the North Sea in this respect. The higher fecundity in the Baltic is not related to age, as suggested by Franz in 1910, nor with the actual supply of food, as the Baltic fish nowadays grow rapidly, though in about 1900 they grew very slowly, on account of overcrowding. The fecundity seems to be just the same as it was then.

The factors governing the fecundity of individual fish are, as Simpson points out, in the main unknown. The number of eggs may be already determined by the time the germinal epithelium is formed during the first year of life or later when (and if) new oocytes are formed, or the eggs to be spawned in one year are separated from the store of immature oocytes. Simpson suggests that the annual supply of food, changes in which cause the well known variations in growth-rate, may also regulate the number of oocytes starting their maturation process the same year.

The reviewer, though admitting the importance of external factors in all the physiological processes in fish, would stress also the internal factors in this case. The Baltic plaice population in fact suggests that the number of eggs is not related to the actual supply of food. In a paper on natural selection and egg number in fish (reviewed in the Journal, Vol. XVII, pp. 198—199) the present reviewer has pointed out that the actual number of eggs in fish would tend to be determined by the balance between the relative strengths of intraspecific and interspecific competition. It follows that a species would tend to have more eggs on the borders of its distribution than in the centre, where intraspecific competition is highest and the premium on large eggs consequently greatest. The south-western Baltic is the only part of this sea where plaice can live continuously. In this border region therefore, where both the biological and the hydrographical environment must be unfavourable, egg numbers would — on theoretical grounds — be raised to a higher level than elsewhere. This seems to be true. Danish workers have found that the Baltic population of plaice is a distinct subspecies, which in turn suggests a long isolation from the North Sea population. The smaller differences in fecundity found within the North Sea or on the Murman coast of course might be genetic too, and produced by natural selection. Consequently within

a local population also some of the individual variation might be due to genetical heterozygoty — wich is not mentioned by Simpson.

Simpson's paper will certainly interest all those engaged on the problem of fecundity in fish.

G. Svärdson.

G. Dannevig. "Sprats from Norwegian Waters. An Analysis of Vertebrae Counts." Rep. Norw. Fish. Mar. Invest., **9**, 12, pp. 1—22, 4 figs. Bergen, 1951.

In this paper Dannevig compares the vertebrae counts of 0-group sprats and also of I-group sprats of various lengths. He shows that there is a significant difference in the vertebrae counts of the smaller and larger fish. In an analysis of the vertebrae counts of samples taken from various parts of the Norwegian coast between 1927 and 1949, he points out that there is a considerable variation between samples taken within one year. As he has found that there is a difference between the vertebrae counts of samples taken at the same place within a short period of each other, he suggests that considerable care should be taken in arriving at the vertebrae count if it is to be used to compare with those made in other years. It is necessary to obtain a representative length-distribution before attempting the vertebrae counts and until this is done, it would appear from this paper that the value of vertebrae counts is open to doubt.

I. R.

Åge Jonsgård. "Studies on the Little Piked Whale or Minke Whale (*Balaenoptera acuto-rostrata* Lacépède). Report on Norwegian investigations carried out in the years 1943—1950." Norwegian Whaling Gazette, No. 5, 54 pp., 10 figs. Sandefjord, 1951.

The Little Piked Whale or Lesser Rorqual, generally known to whalers by the Norwegian name, "Minke", is a relatively small baleen whale, and until recently has received considerably less attention either from whalers or from biologists than have the larger species. It has long been hunted, however, in Norwegian waters, and in recent years has become the object of an industry of considerable local importance, extending from the North Sea to the Arctic, with an average annual catch of more than 2000 whales. Successful exploitation of any natural population of such animals generally calls for some form of regulation and measures for the conservation of the stock, and for this purpose biological information on the population is needed. In the absence of commercial hunting the Cetacea are among the most inaccessible of animals, but when an industry develops access becomes easier. Mr. Jonsgård, of Statens Institutt for Hvalforskning, in Oslo, has carried out an extensive programme of research over a number of years, and with the co-operation of the whalers appears to have made very good use of the opportunities to collect material and statistics. In a foreword by Professor J. T. Ruud it is intimated that the present paper is not a final analysis of the data, but it contains information which may be of interest to the International Whaling Commission.

The paper is based on details of the catches supplied by the whalers since 1938, and on direct examination by the author of 124 whales from 1943 to 1945, mostly in the Lofoten area, and 111 whales by the author and other biologists in 1950, mostly in Arctic waters. It is probably safe to say that this body of material far exceeds any data of the same kind which

have previously been assembled for this species, and it has enabled Mr. Jonsgård to examine the local distribution and migrations of Minke whales, their food, and to some extent the breeding cycle and rate of growth — subjects on which there was previously very limited information. There are notes also on the history of the local industry, and on the nomenclature and external characters of this species.

From the reports of catches in various regions along the Norwegian coast, and from direct observations, the author is able to confirm the usual tendency for the main part of the population to move towards colder waters in spring and return towards warmer regions (and presumably to unknown breeding grounds) in autumn. It seems evident that the calves do not migrate so far north as the adults.

In Norwegian waters the food includes a great variety of fish (among which herrings predominate) and certain planktonic crustacea. In arctic waters, however, the observations indicate that the Minke feeds mainly on the Euphausiid, *Thysanoessa inermis*. There is evidence that the young are weaned by the time they reach a length of about 15 feet. In the *Antarctic Euphausia superba* constitutes the staple diet of all baleen whales so far as is known (though there is little direct evidence on the food of the southern Minke). In high northern latitudes *Thysanoessa inermis* and *Meganyctiphanes norvegica* both seem to be important, and it would be interesting to know whether the Minke sometimes feeds also on *Meganyctiphanes*.

Since whales cannot be kept under continuous observation for the study of their breeding, growth, and age, it is necessary to rely mainly on the circumstantial evidence provided, for example, by dated foetal lengths, the condition of the genitalia, and the occurrence and distribution of whales in different stages of the reproductive cycle. The author summarizes the conclusions of previous authors, relating to the period of gestation, the length of the calf at birth, and the smallest size at which females become pregnant. He estimates that sexual maturity is reached at a length of about 24 ft. in females and 22 ft. in males. From the high percentage of adult females pregnant, the significant number both pregnant and lactating, and the occurrence of lactating females, he concludes that the majority of adult females give birth to a calf once a year, and are probably impregnated again before starting on their northward migration. It is provisionally estimated that pairing takes place between January and May, and that the suckling period is not longer than 4—5 months. When body-length is plotted against weight of ovary or testis the points show some tendency to fall into groups. These are attributed to age-groups and it is tentatively inferred that sexual maturity can be reached at an age of 2 years.

Although the more immediate value of the work may lie in its bearing on the local whaling industry, its significance of course goes much farther. The Minke whale is widely distributed and might become of importance in other regions. Small whales seen in the colder antarctic waters, for instance, are believed to be of the same species, and may be more abundant there than they appear to be, for it is an inconspicuous whale. Furthermore such investigations may well advance what is known of the biology of the rorquals in general, since the relatively manageable size of the Minke should facilitate anatomical work, and as a species which is common in north European coastal waters its habits can in some ways perhaps be more readily examined. The report is a welcome addition to what is known of the populations of baleen whales.

N. A. M.

Current Bibliography.

Prepared by the Editor with the Assistance of Mr. A. C. Simpson.

NOTE. The scope of the Bibliography is limited in the main to the area covered by the Council's activities, but there are included papers of general interest relating to other areas in North Temperate and Arctic regions and exceptionally elsewhere. Limnological references are not as a rule given, but papers relating to brackish waters and to salmon and freshwater fish studied by the Council are included.

Subscribers and those on the distribution list will receive regularly upon application to the General Secretary copies of the Bibliography printed on one side of the page only, for use in making up card indices.

The Editor will be glad to be advised of emendations and additions to the Bibliography.

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1) General Oceanography.

1) a Expeditions.

Mackintosh, N. A. "The work of the Discovery Committee". Proc. Roy. Soc. A, **202**, pp. 1—16, London, 1950.

Seehusen, K. H. "The Danish 'Galathea' Expedition (1950—52)". Internat. Hydrogr. Rev., **27**, 2, pp. 17—19, Monte Carlo, 1950.

1) b Institutes.

Anon. "Freshwater Biological Association. Opening of Windermere Laboratory". Nature, **166**, 4233, pp. 1021—3, London, 1950.

Anon. "Annual report for 1950". Fish. Res. Board Canada, Ottawa, 1951.

Anon. "Annual report No. 5, 1950". German Hydrogr. Inst., Hamburg, 1951.

Anon. "Annual report for 1950". Internat. Pacific Salmon Fish. Comm., New Westminster, 1951.

Anon. "Hawaii Marine Laboratory". Univ. Hawaii, Honolulu, 1951.

Leipper, D. F. "The establishment of the Department of Oceanography in the Agricultural and Mechanical College of Texas". Trans. American Geophys. Union, **31**, 5, Pt. 1, pp. 789—91, Washington, 1950.

Studds, R. F. A. "Oceanographic activities of the U.S. Coast and Geodetic Survey". Trans. American Geophys. Union, **31**, 5, Pt. 1, pp. 786—8, Washington, 1950.

2) Hydrography.

2) a Apparatus and Methods.

Armstrong, F. A. J. "The determining of silicate in sea water". Journ. Mar. Biol. Assoc. U.K., **30**, pp. 149—60, Cambridge, 1951.

Arx, W. S. von. "An electromagnetic method for measuring the velocities of ocean currents from a ship under way". Mass. Inst. Technol. Meteorol. Pap., **11**, 3, Cambridge, Mass., 1950.
Dussart, B. & Francis-Bœuf, C. "Technique du dosage l'oxygène dissous dans l'eau basée sur la méthode de Winkler". Circ. Cent. Rech. d'Études Océanogr., Instruct. Techn., 1, Paris, 1949.
La Fond, E. C., Dietz, R. S. & Knauss, J. A. "A sonic device for underwater sediment surveys". Journ. Sediment. Petrol., **20**, pp. 107—10, Tulsa, Okla., 1950.
Hardon, H. J. "The determination of chlorine and oxygen content". Snellius Exped., **2**, Oceanogr. Results, 1, Methods and Instruments, Chap. 2, Leiden, 1941.
Hermann, F. "High accuracy potentiometric determination of the chlorinity of sea water". Cons. Perm. Internat. Explor. Mer, Journ. du Cons.. **17**, 3, pp. 223—30, Copenhague, 1951.
Isaacs, J. D. & Wiegell, R. L. "The thermopile wave meter". Trans. American Geophys. Union, **31**, 5, Pt. 1, pp. 711—6, Washington, 1950.
Iselin, C. O'D. "Principal instrumentation problems of deep-sea oceanographic exploration". Instruments, **22**, pp. 898—901, Pittsburg, 1949.
Lüders, K. "Ein neues Zeichengerät für die Auswertung von Gezeitenkurven". Deutsch. Hydrogr. Zeitschr., **3**, 5/6, pp. 362—5, Hamburg, 1950.
Menaché, M. "Réalisation d'une loupe de lecture sans parallaxe, son application aux mesures océanographiques". Circ. Cent. Rech. d'Études Océanogr., 3, Paris, 1950.
Turpin, J. P. "Note sur une avarie assez fréquente des thermomètres à renversement et sur la façon d'y remédier". Ann. Hydrogr., **20**, pp. 55—6, Paris, 1948.
Villain, C. "Notice sur l'emploi des thermomètres à renversement". Ann. Hydrogr., **20**, pp. 43—56, Paris, 1948.
Wohlenberg, E. "Der horizontale Wasserschöpfer". Deutsch. Hydrogr. Zeitschr., **3**, 5/6, pp. 365—8, Hamburg, 1950.

2) b Surveys.

Alander, H. "Baltic Area. Hydrography. Swedish Observations". Cons. Perm. Internat. Explor. Mer, Ann. Biol., **5**, pp. 133—4, Copenhague, 1949.
Anon. "Kungl. Fiskeristyrelsens Fyrskeppsundersökning År 1948—1949". Göteborg, 1951.
Anon. "Nautical-Meteorological Annual, 1950". Publ. Danske Meteorol. Inst., København, 1951.
Anon. "Observations of sea water temperature, salinity, and density on the Pacific coast of Canada". Pacific Oceanogr. Group, Pacific Biol. Stat., **10**, Nanaimo, B.C., 1951.
Böhnecke, G. & Dietrich, G. "Monatskarten der Oberflächentemperatur für die Nord- und Ostsee und die angrenzenden Gewässer". Deutsch. Hydrogr. Inst., Hamburg, 1951.
Dannevig, A. "Transition Area. Hydrography. Norway coast of Skagerak". Cons. Perm. Internat. Explor. Mer, Ann. Biol., **5**, p. 118, Copenhague, 1949.
Deacon, G. E. R. "Advances in oceanographic research". The Times, Prog. Sci., 1, pp. 5—6, London, 1951.
Defant, A. "Reality and illusion in oceanographic surveys". Journ. Mar. Res., **9**, 3, pp. 120—38, New Haven, Conn., 1950.
Dunbar, M. J. "Eastern arctic waters". Bull. Fish. Res. Board Canada, 88, Ottawa, 1951.
Glowinska, A. "Baltic Area. Hydrography. Observations off the Polish coast, 1947 and 1948". Cons. Perm. Internat. Explor. Mer, Ann. Biol., **5**, pp. 131—3, Copenhague, 1949.
Hermann, F. "North-western Area. Hydrography. Section from the Faroes to East Greenland". Cons. Perm. Internat. Explor. Mer, Ann. Biol., **5**, p. 16, Copenhague, 1949.
Hermann, F. "Hydrographic conditions in the south-western part of the Norwegian Sea". Cons. Perm. Internat. Explor. Mer, Ann. Biol., **5**, pp. 19—21, Copenhague, 1949.
Jensen, Aa. J. C. "Baltic Area. Hydrography. Danish Observations". Cons. Perm. Internat. Explor. Mer, Ann. Biol., **5**, p. 131, Copenhague, 1949.
Ketchum, B. H., Redfield, A. C. & Ayers, J. C. "The oceanography of the New York Bight". Pap. Phys. Oceanogr. Meteorol., **12**, 1, Cambridge, Mass., 1951.
Kiilerich, A. "Hydrography in the neighbourhood of Disko (Greenland) in the summer of 1948, with remarks on the cod fishery". Cons. Perm. Internat. Explor. Mer, Ann. Biol., **5**, pp. 24—9, Copenhague, 1949.

Rochford, D. J. "Studies in Australian estuarine hydrology. 1. Introductory and comparative features". Australian Journ. Mar. Freshwater Res., **2**, 1, pp. 1—116, Melbourne, 1951.

Rouch, J. "Le Canal de Panama". Bull. Inst. Océanogr., 975, Monaco, 1950.

Saur, J. F. T. "Oceanographic features of Nodales Channel (British Columbia) with application to underwater sound". U.S. Navy Electronics Lab., San Diego, Rep. 188, 4, San Diego, 1950.

Stefánsson, U. & Hermann, F. "North-western Area. Hydrography. N. of Iceland 1948". Cons. Perm. Internat. Explor. Mer, Ann. Biol., **5**, pp. 16—9, Copenhague, 1949.

Tait, J. B. "N. North Sea. Hydrography. Scottish investigations". Cons. Perm. Internat. Explor. Mer, Ann. Biol., **5**, pp. 53—6, Copenhague, 1949.

Thomsen, H. "Temperature and salinity in the permanent sections of the west coast of Greenland 1948". Cons. Perm. Internat. Explor. Mer, Ann. Biol., 5, pp. 21—2, Copenhague, 1949.

Thomsen, H. "Hydrographical investigations in Baffin Bay". Cons. Perm. Internat. Explor. Mer, Ann. Biol., **5**, pp. 22—4, Copenhague, 1949.

Thomsen, H. "Southern North Sea. Hydrography". Cons. Perm. Internat. Explor. Mer, Ann. Biol., **5**, p. 89, Copenhague, 1949.

2) c Chemistry of Sea Water.

Anon. "Observacões Oceanográficas, 'Albacora', 1930, 1938, e 1939": "— — — 1940". Trav. Stat. Biol. Marit. de Lisbonne, 44, 45, Lisboa, 1941: 1942.

Anon. "Nautisk-Meteorologisk Årbog 1949". Publ. Danske Meteorol. Inst., København, 1950.

Darmois, R. & J. "Déterminations physicochimiques en Mer du Nord". C. R. Acad. Sci., **230**, pp. 316—7, Paris, 1950.

Eucken, A. "Der Einfluss gelöster Stoffe auf die Konstitution des Wassers". Nachr. Akad. Wiss. Göttingen, Math.-phys. Klasse, 2, p. 33, Göttingen, 1947.

Geyer, R. A. "The occurrence of pronounced salinity variations in Louisiana coastal waters". Journ. Mar. Res., **9**, 3, pp. 100—10, New Haven, Conn., 1950.

Granqvist, G. "The increase of the salinity along the coast of Finland since 1940". Fennia, **71**, 2, pp. 1—17, Helsingfors, 1949.

Halme, E. "Planktologische Untersuchungen in der Pojo-Bucht und angrenzenden Gewässern. 1. Milieu und Gesamtplankton". Ann. Zool. Soc. Zool. Bot. Fenn. Vanamo, **10**, 2, Helsinki, 1944.

Kalle, K. "Meereskundlich-chemische Untersuchungen mit Hilfe des Pulfrich-Photometers von Zeiss. VII. Mitteilung. Die Mikrobestimmungen des Chlorophylls und der Eigenfluoreszenz des Meerwassers". Deutsch. Hydrogr. Zeitschr., **4**, 3, pp. 92—6, Hamburg, 1951.

Lewis, G. J., & Thompson, T. G. "The effect of freezing on the sulfate/chlorinity ratio of sea water". Journ. Mar. Res., **9**, 3, pp. 211—7, New Haven, 1950.

Matsue, Y. "The variation of titratable base in sea water". Journ. Oceanogr. Soc. Japan, **6**, 1, pp. 32—8, Tokyo, 1950. (In Japanese, English summary).

Menaché, M. "Du choix d'une eau normale pour la Méditerranée". Bull. Inst. Océanogr., 980, Monaco, 1950.

Pocinki, L. S. "The application of conformal transformations to ocean wave refraction problems". Trans. American Geophys. Union, **31**, 6, pp. 856—66, Washington, 1950.

Saeki, A. "Silicon in the water. 2. Its colorimetric determination in sea water. 3. Variation of the values estimated by the colorimetric method in the fresh water and its mixed solution with the sea water". Journ. Oceanogr. Soc. Japan, **6**, 1, pp. 39—47, Tokyo, 1950. (In Japanese, English summary).

Tully, J. P. "Seasonal cycles in the sea". Prog. Rep. Pacific Coast Stat., 85, pp. 88—90, Vancouver, B. C., 1950.

Wooster, W. S., & Rakestraw, N. W. "The estimation of dissolved phosphate in sea water". Journ. Mar. Res., **10**, 1, pp. 91—100, New Haven, 1951.

2) d Physical Properties.

Darmois, M. & R. "Détermination du coefficient de pureté de la Méditerranée au large de Banyuls-sur-Mer". C. R. Acad. Sci. Paris, **226**, pp. 740—2, Paris, 1948.

Darmois, R. & J. "Déterminations physicochimiques en Mer du Nord". ibid., **230**, pp. 316—7, Paris, 1950.

Dorrestein, R. "General linearized theory of the effect of surface films on water ripples". Proc. Kon. Ned. Akad. v. Wet., Ser. B, **54**, 3/4, Amsterdam, 1951.
Ewing, G. "Slicks, surface films and internal waves". Journ. Mar. Res., **9**, 3, pp. 161—87, New Haven Conn., 1950.
Halme, E. "Planktologische Untersuchungen in der Pojo-Bucht und angrenzenden Gewässern. 1. Milieu und Gesamtplankton". Ann. Zool. Soc. Zool. Bot. Fenn. Vanamo, **10**, 2, Helsinki, 1944.
Simojoki, H. "Niederschlag und Verdunstung auf dem Baltischen Meer". Fennia, **71**, 1, pp. 1—25, Helsingfors, 1949.

2) e Temperatures.

Dietrich, G. "Über systematische Fehler in den beobachteten Wasser- und Lufttemperaturen auf dem Meere und über ihre Auswirkung auf die Bestimmung des Wärmeumsatzes zwischen Ozean und Atmosphäre". Deutsch. Hydrogr. Zeitschr., **3**, 5/6, pp. 314—24, Hamburg, 1950.
Hesselberg, T. "Sekulær variasjon av sjöens overflatetemperatur langs Norges kyst". Naturen, **72**, pp. 257—63, Bergen, 1948.
Lauzier, L. "Unusually warm surface sea-water in 1949". Prog. Rep. Atlantic Coast Stat., 51, pp. 17—9, St. Andrews, N.B., 1950.
Neumann, G. "Über Temperaturanomalien an der Meeresoberfläche und ihre Beziehungen zur atmosphärischen Zirkulation". Deutsch. Hydrogr. Zeitschr., **3**, 3/4, pp. 206—13, Hamburg, 1950.
Smed, J. "North-western Area. Hydrography. N.E. North Atlantic". Cons. Perm. Internat. Explor. Mer, Ann. Biol., **5**, pp. 10—5, Copenhague, 1949.
Tully, J. P. "Seasonal cycles in the sea". Prog. Rep. Pacific Coast Stat., 85, pp. 88—90, Vancouver, B.C., 1950.
Wahl, E. "Temperaturmessungen in der Nordsee im Sommer 1948". Ann. Meteorol., **2**, pp. 65—71, Hamburg, 1951.
Waldie, R. J., Doe, L. A. E. & others. "Oceanographic discovery". Prog. Rep. Pacific Coast Stat., 84, pp. 59—63, Vancouver, B.C., 1950.

2) f Submarine Illumination.

Halme, E. & Kaartotie, T. "Planktologische Untersuchungen in der Pojo-Bucht und angrenzenden Gewässern. II. Über die Strahlungsverhältnisse im Wasser. Vorläufige Mitteilung". Ann. Zool. Soc. Zool. Bot. Fenn. Vanamo, **11**, 7, pp. 1—22, Helsinki, 1946.
Polli, S. "Ricerche di fotometria subacquea nelle acque della Laguna di Venezia". Pubbl. Inst. Talassograf., 265, pp. 1—13, Trieste, 1950.
Takenouti, Y. "On the diffusion-ratio of underwater illuminations". Oceanogr. Mag., **1**, pp. 43—8, Tokyo, 1949.

2) g Hydrodynamics.

Ackert, J. "Verhinderung des Turbulentwerdens einer Grenzschicht durch Absaugung". Naturwissenschaften, **29**, 41, p. 622, Berlin, 1941.
Defant, A. "Der Einfluss des Windes auf das Massenfeld und die Konvektionsströme im Meer". Forsch. u. Fortschr., 21—3, Berlin, 1947.
Görtler, H. "Neuere Beiträge zur Dynamik atmosphärischer und ozeanographischer Strömungen". Naturwissenschaften, **29**, 32/33, Berlin, 1941.
Hidaka, K. "Lateral mixing and wind-driven currents in an enclosed ocean". Journ. Mar. Res., **9**, 2, pp. 55—64, New Haven, Conn., 1950.
Hidaka, K. "Mass transport in ocean currents and the lateral mixing". Journ. Oceanogr. Soc. Japan, **6**, 1, pp. 48—52, Tokyo, 1950.
Hidaka, K. "Effect of land barriers upon the wind-driven current in the ocean". Journ. Oceanogr. Soc. Japan, **6**, 1, pp. 53—56, Tokyo, 1950.
Hidaka, K. "Mass transport in convection currents and the lateral mixing". ibid., **6**, 1, pp. 57—67, Tokyo, 1950.
Hidaka, K. & Miyoshi, H. "On the neglect of the inertia terms in dynamical oceanography". Journ. Oceanogr. Soc. Japan, **6**, 1, pp. 68—76, Tokyo, 1950.
Ichie, T. "On the diffusion in the field of Coriolis force". Oceanogr. Mag., **1**, pp. 121—7, Tokyo, 1949.
Ichie, T. "On the stationary internal waves caused by the bottom configuration". Journ. Oceanogr. Soc. Japan, **6**, 1, pp. 1—7, Tokyo, 1950. (In Japanese, English summary).
Ichie, T. "On the non-stationary motion of the bay water by the wind stress". Journ. Oceanogr. Soc. Japan, **6**, 1, pp. 8—14, Tokyo, 1950. (In Japanese, English summary).

Liesegang, R. E. "Zur Problematik der sogenannten Uri-Lloyd Schichtung und ihrer möglichen Bedeutung für Meereskunde, Geologie und Meteorologie". Naturwissenschaften, **29**, 27, Berlin, 1941.

Miller, A. R. "A study of mixing processes over the edge of the continental shelf". Journ. Mar. Res., **9**, 3, pp. 145—60, New Haven, Conn., 1950.

Miyazaki, M. "On the distribution of the drift current and the suspending sands in a channel". Journ. Oceanogr. Soc. Japan, **6**, 1, pp. 15—7, Tokyo, 1950. (In Japanese, English summary).

Neumann, G. "Die Meeresoberfläche als hydrodynamische Grenzfläche und das Windfeld über den Wellen". Ann. Meteorol., **2**, pp. 156—64, Hamburg, 1949.

Prandtl, L. "Über ein neues Formelsystem für die ausgebildete Turbulenz". Nachr. Akad. Wiss. Göttingen, Math.-phys. Klasse, p. 6, Göttingen, 1945.

Riegel, S. F. & Zaat, J. A. "Zum Übergang von Grenzschichten in die ungestörte Strömung". Nachr. Akad. Wiss. Göttingen, Math.-phys. Klasse 2, p. 42, Göttingen, 1947.

Saito, Y. "On the vertical stability of the sea". Oceanogr. Mag., **1**, pp. 112—20, Tokyo, 1949.

2) h Currents and Oceanic Circulation.

Berthois, L. & Collette, G. "Note sur la construction graphique de la spirale d'Ekman". Circ. Cent. Rech. d'Études Océanogr., Instruct. Techn., 2, Paris, 1950.

Carruthers, J. N. & Lawford, A. L. "Water movements and winds". Weather, **5**, 8, pp. 278—83, London, 1950.

Carruthers, J. N., Lawford, A. L. & Veley, V. F. "Studies of water movements and winds at various lightvessels. II. At the Seven Stones lightvessel near the Scilly Isles". Journ. Mar. Biol. Assoc. U.K., **29**, pp. 587—608, Cambridge, 1951.

Dietrich, G. "Die anomale Jahresschwankung des Wärmeinhalts im Englischen Kanal, ihre Ursachen und Auswirkungen". Deutsch. Hydrogr. Zeitschr., **3**, 3/4, pp. 184—201, Hamburg, 1950.

Fuglister, F. C. "Annual variations in current speeds in the Gulf Stream System". Journ. Mar. Res., **10**, 1, pp. 119—27, New Haven, Conn., 1951.

Hansen, W. "Triftstrom und Windstau". Deutsch. Hydrogr. Zeitschr., **3**, 5/6, pp. 303—13, Hamburg, 1950.

Hansen, W. "Beobachtungen des Windstaus und Triftstroms im Modellkanal". Ibid., **4**, 3, pp. 81—91, Hamburg, 1951.

Haurwitz, B. & Panovsky, H. A. "Stability and meandering of the Gulf Stream". Trans. American Geophys. Union, **31**, 5, Pt. 1, pp. 723—31, Washington, 1950.

Hidaka, K. & Suzuki, T. "Secular variation of the Tsushima current". Journ. Oceanogr. Soc. Japan, **6**, 1, pp. 28—31, Tokyo, 1950. (In Japanese, English summary).

Hidaka, K. & Yamagawa, T. "On the absolute velocity of the subarctic intermediate current to the south of Japan". Oceanogr. Mag., **1**, pp. 99—102, Tokyo, 1949.

Ichie, T. "On the theory of the drift current in an enclosed sea". Oceanogr. Mag., **1**, pp. 128—32, Tokyo, 1949.

Laubenfels, M. W. de. "Ocean currents in the Marshall Islands". Geogr. Rev., **40**, pp. 254—9, New York, 1950.

Lisitzin, E. "On current velocity in the Northern Baltic". Fennia, **71**, 3, pp. 1—14, Helsingfors, 1949.

Miyazaki, M. "On the directivity of the current rips". Oceanogr. Mag., **1**, pp. 133—4, Tokyo, 1949.

Munk, W. H. "On the wind-driven ocean circulation". Journ. Meteorol., **7**, pp. 79—93, Lancaster, Pa., 1950.

Munk, W. H., Groves, G. W. & Carrier, G. F. "Note on the dynamics of the Gulf Stream". Journ. Mar. Res., **9**, 3, pp. 218—38, New Haven, Conn., 1950.

Nakamiya, T. & Suda, K. "On the variation of 'Kuroshio'". Hydrogr. Div., Marit. Safety Agency, Tokyo, 1950.

Pollak, M. J. "The sources of the deep water of the eastern Mediterranean Sea". Journ. Mar. Res., **10**, 1, pp. 128—52, New Haven, Conn., 1951.

Schweigger, E. "Atlas de la corriente costanera Peruana". Compania Admin. Guano, Lima, 1951.

Shtokman, V. B. "The influence of bottom relief on the direction of ocean currents". Priroda, 11, p. 10, Leningrad, 1949. (In Russian).

Soule, F. M. "Arctic ice drift and the Humboldt Current". Science, **112**, pp. 61—2, Lancaster, Pa., 1950.

Stommel, H. "Note on the deep circulation of the Atlantic Ocean". Journ. Meteorol., **7**, pp. 245—6, Lancaster, Pa., 1950.
Stommel, H. "An example of thermal convection". Trans. American Geophys. Union, **31**, 4, pp. 553—4, Washington, 1950.
Uda, M. "On the correlated fluctuation of the Kuroshio current and the cold water mass". Oceanogr. Mag., **1**, pp. 1—12, Tokyo, 1949.

2) i Tides and Sea Level.

Arthur, R. S. "Variability in direction of wave travel". Ann. New York Acad. Sci., **51**, 3, pp. 511—22, New York, 1949.
Arthur, R. S. "Refraction of shallow water waves: The combined effect of currents and underwater topography". Trans. American Geophys. Union, **31**, 4, pp. 549—52, Washington, 1950.
Bowden, K. F. "The effect of eddy viscosity on ocean waves". Phil. Mag., Ser. 7, **41**, pp. 907—17, London, 1950.
Dietrich, G. "Die Gezeiten des Weltmeeres als geographische Erscheinung". Zeitschr. Gesell. f. Erdkunde, 3/4, Berlin, 1944.
Dietrich, G. "Influences of tidal streams on oceanographic and climatic conditions in the sea as exemplified by the English Channel". Nature, **168**, p. 8, London, 1951.
Dietz, R. S. & LaFond, E. C. "Natural slicks on the ocean". Journ. Mar. Res., **9**, 2, pp. 69—76, New Haven, Conn., 1950.
Eckart, C. "The ray-particle analogy". Journ. Mar. Res., **9**, 3, pp. 139—44, New Haven, Conn., 1950.
Hamilton, W. S. "Forces exerted by waves on a sloping board". Trans. American Geophys. Union, **31**, 6, pp. 849—55, Washington, 1950.
Hansen, W. "Gezeitenströme im Englischen Kanal". Deutsch. Hydrogr. Zeitschr., **3**, 3/4, pp. 169—83, Hamburg, 1950.
Ketchum, B. H. "The exchanges of fresh and salt waters in tidal estuaries". Journ. Mar. Res., **10**, 1, pp. 18—38, New Haven, Conn., 1951.
Longuet-Higgins, M. S. "A theory of the origin of microseisms". Phil. Trans. Roy, Soc. London, Ser. A, **243**, 857, London, 1950.
Manning, T. H. & Rae, R. W. "Tidal observations in Arctic waters". Arctic, **3**, 2, pp. 95—104, Montreal & New York, 1950.
Marmer, H. A. "Tide observations at Baltimore and the problem of coastal stability". Geogr. Rev., **33**, 4, pp. 620—9, New York, 1943.
Nakano, M. "On the secondary undulations of tides caused by cyclonic storms". Oceanogr. Mag., **1**, pp. 13—32, Tokyo, 1949.
Polli, S. "Le maree all'isola di S. Andrea nell'Adriatico centrale". Pubbl. Inst. Talassograf., 264, Trieste, 1950.
Redfield, A. C. "The analysis of tidal phenomena in narrow embayments". Pap. in Phys. Oceanogr. and Meteorol., **11**, 4, Cambridge, Mass., 1950.
Roll, H. U. "Neue Messungen zur Entstehung von Wasserwellen durch Wind". Ann. d. Meteorol., **4**, 1—6, pp. 269—86, Hamburg, 1951.
Schaaf, S. A. & Sauer, F. M. "A note on the tangential transfer of energy between wind and waves". Trans. American Geophys. Union, **31**, 6, pp. 867—9, Washington, 1950.
Schwinner, R. "Eustatische Meeresspiegelschwankung heute von der Klimaänderung bedingt?". Petermanns Geogr. Mitt., **88**, 2, p. 52, Gotha, 1942.
Tomczak, G. "Die Sturmfluten vom 9. und 10. Februar 1949 an der deutschen Nordseeküste". Deutsch. Hydrogr. Zeitschr., **3**, 3/4, pp. 227—40, Hamburg, 1950.
Ursell, F. "On the theoretical form of ocean swell on a rotating earth". Monthly Not. Roy. Astr. Soc., Geophys. Suppl., **6**, 1, pp. 1—8, London & Edinburgh, 1950.
Ursell, F. "On the application of harmonic analysis to ocean wave research". Science, **111**, pp. 445—6, Lancaster, Pa., 1950.

2) j Geography, Geology and Bottom Deposits.

Angelis, R. de. "La sistemazione idraulica e la trasformazione fondiaria dei comprensori lagunari in Grecia". Boll. Pesca, Piscicolt. e Idrobiol., Ann. 26, **5**, 1, pp. 128—54, Roma, 1950.
Anon. "Limits of oceans and seas". Provisional 3rd Edit., Internat. Hydrogr. Bureau, Spec. Publ., 23, Monte Carlo, 1950.
Bernard, F. & Lecal, J. "Étude des sédiments marins au large d'Alger. 1. Teneur en azote et carbone organique". Bull. Inst. Océanogr., 963, Monaco, 1950.
Dittmer, E. "Küstensenkung an der Schleswig-Holsteinischen Westküste". Forsch. u. Fortschr., 17/18, pp. 214—6, Berlin, 1948.

Kuenen, P. H. "Geological interpretation of the bathymetrical results". Snellius Exped. 1929—30, **5**, Geol. Result., 1, Utrecht, 1935.

Lauwers, J. "Sea deposits". Internat. Hydrogr. Rev., **25**, 2, p. 141, Monaco, 1948.

Kuenen, P. H. "De bodem der wereldzeeën". Nederlands Natur-Geneesk. Cong., Groningen, 1949.

Menard, H. W. "Transportation of sediment by bubbles". Journ. Sediment. Petrology, **20**, pp. 98—106, Tulsa, Okla., 1950.

Menard, H. W. "Sediment movement in relation to current velocity". ibid., **20**, pp. 148—60, Tulsa, Okla., 1950.

Neumann, G. "Das Schwarze Meer". Zeitschr. Gesell. f. Erdk., 3/4, Berlin, 1944.

Ovey, C. D. "On the interpretation of climatic variations as revealed by a study of samples from an equatorial Atlantic deep sea core". Centenary Proc. Roy. Meteorol. Soc., pp. 211—5, London, 1950.

Pratje, O. "Die Bodenbedeckung des Englischen Kanals und die maximalen Gezeitenstromgeschwindigkeiten". Deutsch. Hydrogr. Zeitschr., **3**, 3/4, pp. 201—5, Hamburg, 1950.

Pratje, O. "Die Deutung der Steingründe in der Nordsee als Endmoränen". ibid., **4**, 3, pp. 106—13, Hamburg, 1951.

Riedel, W. R. "Number of Radiolaria in sediments". Nature, **167**, 4237, p. 75, London, 1951.

Schüler, F. "Die Abbildungstreue von Meeresboden-Profilen in Echogrammen". Deutsch. Hydrogr. Zeitsch., **4**, 3, pp. 97—105, Hamburg, 1951.

Weyl, R. "Eine neue Tiefenkarte der Caribischen See und ihre tektonische Ausdeutung". Petermanns Geogr. Mitt., **93**, 4, pp. 173—4, Gotha, 1949.

Zenkovitch, V. P. "The conservation of mesotopographic forms on the bed of a deep sea". Dok. Akad. Nauk S.S.S.R., **73**, 1, p. 67, Leningrad, 1950. (In Russian).

2) k Ice.

Anon. "Atlas der Eisverhältnisse des Nordatlantischen Ozeans und Übersichtskarten der Eisverhältnisse des Nord- und Südpolargebietes". Deutsch. Hydrogr. Inst., Hamburg, 1950.

Anon. "The state of the ice in the Arctic Seas 1948". Append. Nautisk-Meteorol. Årbog 1948, København, 1950.

Fukutomi, T., Kusunoki, K. & Tabata, T. "Study of sea-ice. (12th Report). Some measurements of the wind pressure drift of sea-ice in open sea". Journ. Oceanogr. Soc. Japan, **6**, 1, pp. 18—27, Tokyo, 1950. (In Japanese, English summary).

Hansen, G. J. A. & Sveistrup, P. P. "Arctic ice fluctuations in Julianehaab Bay 1901—37". Medd. om Grønland, **131**, 13, København, 1943.

Jurva, R. "Über den allgemeinen Verlauf des Eiswinters in den Meeren Finlands und über die Schwankungen der grössten Vereisung". Sitzber. Finn. Akad. Wiss., 1941, pp. 67—112, Helsinki, 1944.

Jurva, R. "Über die grösste Geschwindigkeit der Vereisung des Meeres". ibid., 1946, pp. 223—30, Helsinki, 1947.

Nusser, F. "Gebiete gleicher Eisvorbereitungszeit an den deutschen Küsten". Deutsch. Hydrogr. Zeitschr., **3**, 3/4, pp. 220—7, Hamburg, 1950.

Nusser, F. "Die Eisverhältnisse des Winters 1949/50 an den deutschen Küsten zwischen Ems und Oder". ibid., **3**, 5/6, pp. 335—41, Hamburg, 1950.

2) l Meteorology.

Anon. "The Weather Map". Air Min., Met. Off., 3rd Edit., M.O. 225 1, H.M.S.O., London, 1950.

Cummings, N. W. "Minimum evaporation from water surfaces". Trans. American Geophys. Union, **31**, 5, pp. 757—62, Washington, 1950.

Gordon, A. H. "Variation of wind with height at low levels over the sea". Meteorol. Mag., **79**, 940, pp. 295—7, London, 1950.

Jacobs, W. C. "Energy acquired by the atmosphere over the oceans through condensation and through heating from the sea surface". Journ. Meteorol., **6**, 4, pp.266—72, Lancaster, Pa., 1949.

Mecking, L. "Die grönländischen Normannensiedlungen im Licht ozeanischer Bedingungen und der heutigen Erwärmung der Arktis". Petermanns Geogr. Mitt., **93**, 1, pp. 28—33, Gotha, 1949.

3) Plankton.

3) a Apparatus and Methods.

Barnes, H. "A statistical study of the variability of catches obtained with two models of the Hardy Plankton Indicator". Hull Bull. Mar. Ecol., **2**, 16, pp. 283—93, Hull, 1951.

Sheard, K. "Improved methods of collecting marine organisms". Rec. South Austral. Mus., **7**, pp. 11—4, Adelaide, 1941—43.

Wiborg, K. F. "The whirling vessel. An apparatus for the fractioning of plankton samples". Rep. Norw. Fish. and Mar. Invest., **9**, 13, Bergen, 1951.

3) b General.

Halme, E. "Planktologische Untersuchungen in der Pojo-Bucht und angrenzenden Gewässern. I. Milieu und Gesamtplankton". Ann. Zool. Soc. Zool. Bot. Fenn. Vanamo, **10**, 2, Helsinki, 1944.

Kruger, D. "Variations quantitatives des protistes marins au voisinage du port d'Alger durant l'hiver 1949—1950". Bull. Inst. Océanogr., 978, Monaco, 1950.

3) c Phytoplankton.

Dawson, E. Y. "A further study of upwelling and associated vegetation along Pacific Baja, California, Mexico". Journ. Mar. Res., **10**, 1, pp. 39—58, New Haven, 1951.

Grøntved, Jul. "The Phytoplankton of Præstø Fiord". Fol. Geogr. Dan., **3**, No. 6. Copenhagen, 1950.

Grøntved, Jul. "Phytoplankton Studies. 2. A new biological type within the genus *Chaetoceros, Chaetoceros sessilis* sp. nov.". Kgl. Dan. Vidensk. Selsk., Biol. Medd., **18**, 17. København, 1951.

Grøntved, Jul. "*Trichophrya danae* sp. nov., a suctorial protozoan from Greenland waters". Medd. om Grønl., **142**, 8. København, 1951.

Matsue, Y. "The variation of titratable base in sea water". Journ. Oceanogr. Soc. Japan, **6**, 1, pp. 32—8, Tokyo, 1950. (In Japanese, English summary).

Rampi, L. "Su di una rara Diatomea Planctonica il *Coscinodiscus bipartitus* Rattray 1889". Bull. Inst. Océanogr., 981, Monaco, 1950.

Verdiun, J. "Quantum theory and phytoplankton photosynthesis". Science, **112**, 2905, p. 260, Lancaster, Pa., 1950.

3) d Zooplankton.

Bousfield, E. L. "Pelagic Amphipoda of the Belle Isle strait region". Journ. Fish. Res. Board Canada, **8**, 3, pp. 134—63, Toronto, 1951.

Fage, L. "Sur un nouveau cumacé de la côte occidentale d'Afrique. *Eocuma cadenati* nov. sp.". Bull. Mus. Nation. d'Hist. Nat., 2e Sér., **22**, 4, pp. 450—2, Paris, 1950.

Ghirardelli, E. "Osservazioni biologiche e sistematiche sui Chetognati della Baia di Villefranche sur mer". Boll. Pesca, Piscicolt. e Idrobiol., Ann. 26, **5**, 1, pp. 105—27, Roma, 1950.

Hagmeier, A. & Künne, C. "Die Nahrung der Meerestiere". Handb. Seefisch. Nordeuropas, (Lübbert u. Willer), **1**, 5a, Stuttgart, 1950.

Jespersen, P. & Russell, F. S. (Editors). "Fiches d'identification du zooplancton, No. 18—29". Cons. Perm. Internat. Explor. Mer, Copenhague, 1950.

Johnson, M. W. "The post-embryonic development of the copepod *Pseudodiaptomus euryhalinus* Johnson, and its phylogenetic significance". Trans. American Microscop. Soc., **67**, 4, pp. 319—30, Lancaster, Pa., 1948.

Nicholls, A. G. "A revision of the families Diosaccidae Sars, 1906 and Laophontidae T. Scott, 1905 (Copepoda, Harpacticoida)". Rec. South Austral. Mus., **7**, pp. 65—110, Adelaide, 1941—43.

Nouvel, H. "Mysidacea". Cons. Internat. Explor. Mer, Fiches d'Ident. Zoopl., Nos. 18—27, Copenhague, 1950.

Rees, C. B. "The identification and classification of lamellibranch larvae". Hull Bull. Mar. Ecology, **3**, 19, pp. 73—104, Hull, 1950.

Russell, F. S. "Hydromedusae". Cons. Internat. Explor. Mer, Fiches d'Ident. Zoopl., Nos. 28—29, Copenhague, 1950.

Sheard, K. "Plankton characteristics at the Cronulla onshore station, New South Wales, 1943—46". Bull. Commonwealth Sci. Industr. Res. Organiz., 246, Melbourne, 1949.

Tesch, J. J. "The Gymnosomata II". Carlsb. Found. Oceanogr. Exped. round the World 1928—30, Dana Rep. 36, Copenhagen, 1950.

3) e Physiology and Behaviour.

Batham, E. et al. "Preformed Vitamin A in marine crustacea". Proc. Biochem. Soc., Biochem. Journ., **48**, 1, pp. 10—11, Cambridge, 1951.

Matsue, Y. "The physiological analysis of brine and the preservation of phosphoric acid in *Skeletonema costatum*". Journ. Fish. Res. Inst., 2, pp. 34—49, Tokyo, 1949.

4) Organic Production.

4) a General.

Steemann Nielsen, E. "Measurement of the production of organic matter in the sea by means of Carbon—14". Nature, **167**, p. 684, London, 1951.

4) b Bacteria.

Devèze, L. "Contribution à l'étude des bactéries des eaux en relation avec les variations du milieu". Bull. Inst. Océanogr., 973, Monaco, 1950.

Devèze, L. "Description d'un appareil de prélèvements d'eau à différentes profondeurs en vue d'une étude microbiologique". Vie et Milieu, **1**, 2, pp. 178—84, Paris, 1950.

Hutton, W. E. & Zobell, C. E. "The occurrence and characteristics of methane oxidizing bacteria in marine sediments". Journ. Bacteriol., **58**, 4, pp. 463—73, Baltimore, 1943.

Johnson, F. H. & Zobell, C. E. "The retardation of thermal disinfection of *Bacillus subtilis* spores by hydrostatic pressure". Journ. Bacteriol., **57**, 3, pp. 353—8, Baltimore, 1949.

Johnson, F. H. & Zobell, C. E. "The accelerations of spore disinfection by urethan and its retardation by hydrostatic pressure". ibid., **57**, 3, pp. 359—62, Baltimore, 1949.

Wood, E. J. F. "The classification of bacteria, with special reference to non-pathogenic eubacteria". Proc. Linn. Soc. N. S. Wales, **75**, 3—4, pp. 195—213, Sydney, 1950.

Zobell, C. E. & Johnson, F. H. "The influence of hydrostatic pressure on the growth and viability of terrestrial and marine bacteria". Journ. Bacteriol., **57**, 2, pp. 179—89, Baltimore, 1949.

5) Bottom Fauna and Flora.

5) b Systematics and Development.

Belloc, G. "Catalogue des types de céphalopodes du Musée Océanographique de Monaco". Bull. Inst. Océanogr., 970, Monaco, 1950.

Belloc, G. "Catalogue des types d'acariens marins du Musée Océanographique de Monaco". ibid., 971, Monaco, 1950.

Belloc, G. "Catalogue des types d'échinodermes du Musée Océanographique de Monaco". ibid., 976, Monaco, 1950.

Broch, H. "Stylasteridae (Hydrocorals) from southern seas". Discovery Rep., **26**, pp. 33—46, Cambridge, 1950.

Cherbonnier, G. "Note sur une Holothurie dendrochirote de Dakar: *Cladodactyla senegalensis* Panning". Bull. Mus. Nation. d'Hist. Nat., 2e Sér., **22**, 4, pp. 476—9, Paris, 1950.

Clark, A. H. "A monograph of the existing crinoids: the comatulids, Vol. 1 — Superfamily Tropiometrida. Part 4c". U.S. Nat. Mus. Bull., 82, Washington, 1950.

Coe, W. R. "Divergent methods of development in morphologically similar species of prosobranch gastropods". Journ. Morphol., **84**, 2, pp. 383—99, Boston, 1949.

Loosanoff, V. L., Miller, W. S. & Smith, P. B. "Growth and setting of larvae of *Venus mercenaria* in relation to temperature". Journ. Mar. Res., **10**, 1, pp. 59—81, New Haven, 1951.

Picard, J. "Notes sur les Hydraires méditerranéens". Vie et Milieu, **1**, 2, pp.191—7, Paris, 1950.

Powell, A. W. B. "Antarctic and Subantarctic Mollusca: Pelecypoda and Gastropoda". Discovery Rep., **26**, pp. 47—196, Cambridge, 1951.
Rees, C. B. "The identification and classification of lamellibranch larvae". Hull Bull. Mar. Ecol., **3**, 19, pp. 73—104, Hull, 1950.
Silvestri, A. "Foraminiferi della Laguna Veneta". Boll. Pesca, Piscicolt. e Idrobiol., Ann. 26, **5**, 1, pp. 22—98, Roma, 1950.
Stephenson, W. "The development of *Cirratulus cirratus* (O. F. Müller)". Rep. Dove Mar. Lab. Cullercoats, 3 Ser., 11, pp. 7—20, Newcastle-on-Tyne, 1950.
Stephenson, W. "An epitokous cirratulid occurring in the Cullercoats tanks". Rep. Dove Mar. Lab. Cullercoats, 3 Ser., 11, pp. 21—30, Newcastle-on-Tyne, 1950.

5) c Distribution and Ecology.

Angelier, E. "Recherches sur la faune des littoraux méditerranéens". Vie et Milieu, **1**, 2, pp. 185—90, Paris, 1950.
Ankel, W. E. "Ein rankenfüssiger Krebs mit Schaumfloss *(Lepas fascicularis)*". Natur u. Volk, **80**, 11/12, pp. 309—20, Frankfurt a. M., 1950.
Barnes, H. & Powell, H. T. "The development, general morphology and subsequent elimination of barnacle populations, *Balanus crenatus* and *B. balanoides*, after a heavy initial settlement". Journ. Anim. Ecology, **19**, 2, pp. 175—9, Cambridge, 1950.
Broch, H. "Stylasteridae (Hydrocorals) from southern seas". Discovery Rep., **26**, pp. 33—46, Cambridge, 1950.
Einarsson, H. "Echinoderma". Zool. Iceland, **4**, part 70, Copenhagen & Reykjavik, 1948.
Krause, H. R. "Aufwuchs auf dem Sipho der Sand-Klaffmuschel *(Mya arenaria)*". Natur u. Volk, **81**, 1/2, pp. 8—12, Frankfurt a. M., 1951.
Kühl, H. "Studien über die Sandklaffmuschel *Mya arenaria*". Arch. f. Fisch. Wiss., **2**, 1/2, pp. 25—39, Hamburg, 1950.
Linke, O. "Neue Beobachtungen über Sandkorallen-Riffe in der Nordsee". Natur u. Volk, **81**, 3/4, pp. 77—84, Frankfurt a. M., 1951.
Powell, A. W. B. "Antarctic and Subantarctic Mollusca: Pelecypoda and Gastropoda". Discovery Rep., **26**, pp. 47—196, Cambridge, 1951.
Schuster, O. "Die Käferschnecke *Trachydermon cinereum* und die Napfschnecke *Patella vulgata*, zwei Tiere der Brandungszone". Natur u. Volk, **81**, 3/4, pp. 54—7, Frankfurt a. M., 1951.

5) d Physiology and Behaviour.

Batham, E. J. & Pantin, C. F. A. "Muscular and hydrostatic action in the sea-anemone *Metridium senile* (L)". Journ, Exper. Biol., **27**, 3—4, pp. 264—89, Cambridge, 1950.
Batham, E. J. & Pantin, C. F. A. "Inherent activity in the sea-anemone *Metridium senile* (L)". ibid., **27**, 3—4, pp. 290—301, Cambridge, 1950.
Batham, E. J. & Pantin, C. F. A. "Phases of activity in the sea-anemone *Metridium senile* and their relation to external stimuli". ibid., **27**, 3—4, pp. 377—99, Cambridge, 1950.
Bourdillon, A. "Note sur le commensalisme des *Modiolaria* et des Ascidies". Vie et Milieu, **1**, 2, pp. 198—9, Paris, 1950.
Rothschild, Lord. "The respiration of sea-urchin spermatozoa". Journ. Exper. Biol., **27**, 3—4, pp. 420—36, Cambridge, 1950.
Rothschild, Lord & Swann, M. M. "The fertilization reaction in the sea-urchin egg. The effect of nicotine". Journ. Exper. Biol., **27**, 3—4, pp. 400—6, Cambridge, 1950.
Trueman, E. R. "Observations on the ligament of *Mytilus edulis*". Quart. Journ. Microscop. Sci., **91**, 3, pp. 225—35, Oxford & London, 1950.
Tuzet, O. "La fécondation des Eponges calcaires". Vie et Milieu, **1**, 2, pp. 163—77, Paris, 1950.
Waterman, T. H. "A light polarization analyzer in the compound eye of limulus". Science, **111**, 2880, pp. 252—4, Lancaster, Pa., 1950.

5) f Marine Plants.

Abbott, I. A. "Brackish-water algae from the Hawaiian Islands". Pacific Sci., **1**, 4, pp. 193—214, Honolulu, 1947.
Drew, K. "Occurrence of *Asparagopsis armata* Harv. on the coast of Cornwall". Nature, **166**, 4229, pp. 873—4, London, 1950.

6) Fish.

6) a Systematics, Morphology and Development.

Einarsson, H. "The post-larval stages of Sand-eels (Ammodytidae) in Faroe, Iceland and W-Greenland waters". Acta Natur. Islandica, **1**, 7, Reykjavik, 1951.

Fraser-Brunner, A. "Studies in Plectognath fishes. 1. An interesting new genus of Triacanthodid fishes from the Celebes Sea". Carlsberg Found. Oceanogr. Exped. round the World 1928—30, Dana Rep. 35, Copenhagen, 1950.

Hile, R. "A monograph for the computation of the growth of fish from scale measurements". Trans. American Fish. Soc., **78**, pp. 156—62, New York, 1950.

Luling, K. H. "Zur intraovarialen Entwicklung und Embryologie des Rotbarsches (*Sebastes marinus* L.)". Zool. Jahrb. (Anat.), **71**, 2, pp. 145—288, Jena, 1951.

Morrow, J. E. "Studies on the marine resources of southern New England. VIII. The biology of the Longhorn Sculpin, *Myoxocephalus octodecimspinosus* Mitchill, with a discussion of the southern New England 'Trash' fishery". Bull. Bingham Oceanogr. Collect., **13**, 2, pp. 1—89, New Haven, 1951.

Smith, J. L. B. "The sea fishes of southern Africa". Central News Agency, South Africa, 1950.

Sparta, A. "Uova e larve di Gobiidae. 5. *Gobius capito* C. V.". Boll. Pesca, Piscicolt. e Idrobiol., Ann. 26, **5**, 1, pp. 99—104, Roma, 1950.

6) b Distribution and Fluctuations.

Barnes, H. & Bagenal, T. B. "A statistical study of variability in catch obtained by short repeated trawls taken over an inshore ground". Journ. Mar. Biol. Assoc. U. K., **29**, pp. 649—60, Cambridge, 1951.

Connell, C. H. & Cross, J. B. "Mass mortality of fish associated with the protozoan *Gonyaulax* in the Gulf of Mexico". Science, **112**, 2909, pp. 359—63, Lancaster, Pa., 1950.

Fairbairn, W. J. "Occurrence of *Myxine* off the Berwickshire coast". Nature, **167**, 4237, pp. 72—3, London, 1951.

Meyer, P. F. "Massenauftreten von Neunaugen in den Grossen Seen Nordamerikas". Natur u. Volk, **81**, 8, pp. 180—6, Frankfurt a. M., 1951.

Stubbings, H. G. "Continuous plankton records: Fish eggs and young fish in the North Sea, 1932—39". Hull Bull. Mar. Ecol., **2**, 15, pp. 277—81, Hull, 1951.

6) c Physiology and Behaviour.

Black, V. S. "Changes in body chloride, density, and water content of chum *(Oncorhynchus keta)* and coho *(O. kisutch)* salmon fry when transferred from fresh water to sea water". Journ. Fish. Res. Board Canada, **8**, 3, pp. 164—77, Toronto, 1951.

Buser, J. "Étude des phénomènes de régénération chez quelques poissons téléostéens méditerranéens". Vie et Milieu, **1**, 2, pp. 248—51, Paris, 1950.

Buser, J. "Hypophysectomie et régénération chez les poissons téléostéens". ibid., **1**, 2, pp. 252—4, Paris, 1950.

Durand, J. "Étude morphologique et physiologique du sang, de l'immunité naturelle et acquise chez quelques poissons indochinois". Ann. Inst. Océanogr., **25**, 2, Monaco, 1950.

Elster, H. J. & Mann, H. "Experimentelle Beiträge zur Kenntnis der Physiologie der Befruchtung bei Fischen". Arch. f. Fisch. Wiss., **2**, 1/2, pp. 49—72, Hamburg, 1950.

Fabricius, E. "Heterogeneous stimulus summation in the release of spawning activities in fish". Inst. Freshw. Res., Drottningholm, Rep. 31, pp. 57—99, Lund, 1950.

Fisher, K. C. & Elson, P. F. "The selected temperature of Atlantic salmon and speckled trout and the effect of temperature on the response to an electrical stimulus". Phys. Zool., **23**, 1, pp. 27—34, Chicago, 1950.

Garnaud, J. "La reproduction et l'incubation branchiale chez *Apogon imberis* G. et L.". Bull. Inst. Océanogr., 977, Monaco, 1950.

Liebich, H. & Mann, H. "Über ein proteolytisches Ferment im Fischdarm und die Möglichkeit seiner Verwendung für ein pharmazeutisches Präparat". Arch. f. Fisch. Wiss., **2**, 1/2, pp. 41—9, Hamburg, 1950.

Morcos, S. R. & Salah, M. K. "Utilization of Vitamin A, by freshwater fish". Nature, **167**, 4238, pp. 117—8, London, 1951.

Nikiforov, N. D. & Trusov, V. Z. "Influence of temperature on the embryonal development of fish". Dok. Akad. Nauk S.S.S.R., **73**, 1, p. 209, Leningrad, 1950. (In Russian).
Wales, J. H. "Swimming speed of the western sucker, *Catostomus occidentalis* Ayres". Calif. Fish & Game, **36**, 4, pp. 433—4, San Francisco, 1950.
Zei, M. "Typical sex-reversal in Teleosts". Proc. Zool. Soc. London, **119**, Pt. 4, pp. 917—20, London, 1949.

6) d Parasites and Diseases.

Luling, K. H. "Neuere Untersuchungen über die Parasiten des Rotbarsches: *Sebastes marinus* (L.)". Zeitsch. f. Parasitenk., **15**, pp. 8—24, Hamburg, 1951.

7) Marine Fisheries.

7) b Fish Technology.

Lundborg, M., Levin, O. & Lindahl, B. "Qualitätsvergleich zwischen Heringspräserven (unsteril), deren Rohware mit chloriertem bzw. unchloriertem Wasser gespült wurden". Inst. Mar. Res., Lysekil, Ser. Chem., Rep. 1, Göteborg, 1951.
Tressler, D. K. (Edit.) "Some aspects of food refrigeration and freezing". F.A.O. Agric. Stud., 12, Washington, 1950.

7) c Fishing Vessels and Gear.

Anon. "Probleme der Elektrofischerei". Arch. f. Fisch. Wiss., **2**, 1/2, pp. 73—4, Hamburg, 1950.
Anon. "A new method of long-line fishing developed on the U.S. Pacific coast". Fishing News, 1970, pp. 14—5, London, 1951.
Blackburn, M. & Rayner, G. W. "Pelagic fishing experiments in Australian waters". Commonwealth Sci. Industr. Res. Organiz., Div. Fish., Techn. Pap., 1, Melbourne, 1951.
Elson, P. F. "Usefulness of electrofishing methods". Canad. Fish-Cultur., 9, pp. 3—12, Ottawa, 1950.
Houston, R. B. "German commercial electrical fishing device". U.S. Dept. Interior, Fish & Wildl. Serv., Fish. Leaf. 348, Washington, 1949.
Kreutzer, C. "Die physiologischen Grundlagen der Elektrofischerei im Meer". Arch. f. Fisch. Wiss., **2**, 1/2, pp. 10—4, Hamburg, 1950.
Meschkat, A. "Der 'Düsenjäger' ein neuer Schleppnetztyp". Fischereiwelt, **2**, 12, pp. 177—9, Bremerhaven u. Hamburg-Altona, 1950.
Meyer, P. F. "Der Strukturwandel in der Nachkriegsflotte der Kutterhochsee- und Küstenfischerei". Arch. f. Fisch. Wiss., **2**, 1/2, pp. 14—25, Hamburg, 1950.
Molin, G. "The fitness of nylon thread for manufacture of fishing tackle". Inst. Freshw. Res., Drottningholm, Rep. 31, pp. 113—8, Lund, 1950.
Molin, G. "Result of impregnation experiments". ibid., Rep. 31, pp. 119—26, Lund, 1950.
Schnakenbeck, W. "Stehende Geräte". Handb. Seefisch. Nordeuropas (Willer), **4**, 3, pp. 1—36, Stuttgart, 1940.
Schnakenbeck, W. "Treibnetze". ibid., **4**, 3, pp. 37—48, Stuttgart, 1940.
Schnakenbeck, W. "Schleppnetze". ibid., **4**, 1/2, pp. 1—42, Stuttgart, 1942.
Schnakenbeck, W. "Waden". ibid., **4**, 1/2, pp. 43—52, Stuttgart, 1942.
Wood, H. & Parrish, B. B. "Echo-sounding experiments on fishing gear in action". Cons. Perm. Internat. Explor. Mer, Journ. du Cons., **17**, 1, pp. 25—36, Copenhague, 1950.

7) d Fishing Grounds.

Hodgson, W. C. (Editor). "Fisheries of the North-East Atlantic. Herring Atlas (Fishing Ground, Landing Ports and Quality)". Cons. Perm. Internat. Explor. Mer, 1950.

8) Marine Fishery Investigations.

8) a Stocks and Effects of Fishing.

Anon. "Report on the Sea and Inland Fisheries for the year 1949". Dept. Agric., Fish. Branch, Dublin, 1950.

Blackburn, M. "The Tasmanian whitebait, *Lovettia sealii* (Johnston), and the whitebait fishery". Austral. Journ. Mar. Freshw. Res., **1**, 2, pp. 155—98, Melbourne, 1950.

Oosten, J. van. "A definition of depletion of fish stocks". Trans. Amer. Fish. Soc., **76**, pp. 283—9, New York, 1949.

Thomson, J. M. "The effect of a period of increased legal minimum length of sea mullet in Western Australia". Austral. Journ. Mar. Freshw. Res., **1**, 2, pp. 199—220, Melbourne, 1950.

8) b Cod.

Meyer, P. F. & Kalle, K. "Die biologische Umstimmung der Ostsee in den letzten Jahrzehnten — eine Folge hydrographischer Wasserumschichtungen?". Arch. f. Fisch. Wiss., **2**, 1/2, pp. 1—9, Hamburg, 1950.

Perryman, A. D. "A simple otolith cutter". Cons. Perm. Internat. Explor. Mer, Journ. du Cons., **17**, 1, pp. 37—9, Copenhague, 1950.

8) f Plaice.

Meyer, P. F. & Kalle, K. "Die biologische Umstimmung der Ostsee in den letzten Jahrzehnten — eine Folge hydrographischer Wasserumschichtungen?". Arch. f. Fisch. Wiss., **2**, 1/2, pp. 1—9, Hamburg, 1950.

8) j Herring.

Andersson, K. A. "The herring fishery and the stock of herring in the northern North Sea and the Skagerak during the season 1949—50". Cons. Perm. Internat. Explor. Mer, Journ. du Cons., **17**, 1, pp. 40—3, Copenhague, 1950.

Balls, R. "Environmental changes in herring behaviour: a theory of light avoidance, as suggested by echo-sounding observations in the North Sea". Cons. Perm. Internat. Explor. Mer, Journ. du Cons., **17**, 3, pp. 274—98, Copenhague, 1951.

Bowers, A. B. & Williamson, D. I. "Food of larval and post-larval stages of autumn-spawned herring in Manx waters". Ann. Rep. Port Erin Mar. Biol. Stat., 63, pp. 17—26, Liverpool, 1950.

Bückmann, A. "Die Untersuchungen der Biologischen Anstalt über die Ökologie der Heringsbrut in der südlichen Nordsee". Helgoländer Wiss. Meeresunters., **3**, pp. 1—57, List (Sylt), 1950. (Reprinted, see also bibliography in Journ. du Cons. **17**, 2.)

Friðriksson, Á. & Timmermann, G. "Rannsóknir á hrygningarstöðvum vorgotssíldar vorid 1950". Atvinn. Háskol., Rit Fiskide., 1, pp. 1—32, Reykjavík, 1950.

Friðriksson, Á. & Timmermann, G. "Some remarks on the eggs of herring (*Clupea harengus* L.) and capelin (*Mallotus villosus* (O. F. Müll.)) in Icelandic waters". Cons. Perm. Internat. Explor, Mer, Journ. du Cons., **17**, 3, pp. 261—3, Copenhague, 1951.

Gilis, C. "Observations continuées sur la pêcherie et la biologie des concentrations annuelles de Harengs exploitées par les chalutiers belges dans la Mer du Nord". Zeewetensch. Inst., Oostende, 1951.

Hodgson, W. C. (Editor). "Fisheries of the North-East Atlantic. Herring Atlas (Fishing Ground, Landing Ports and Quality)". Cons. Perm. Internat. Explor. Mer, 1950.

Stevenson, J. C. & Lanigan, J. A. "Results of the west coast of Vancouver Island herring investigation 1949—50". Rep. Brit. Columbia Dept. Fish., pp. 41—80, Victoria, 1949.

8) k Sardine and other Clupeoids.

Blackburn, M. "Studies on the age, growth, and life history of the pilchard, *Sardinops neopilchardus* (Steindachner), in Southern and Western Australia". Austral. Journ. Mar. Freshw. Res., **1**, 2, pp. 221—58, Melbourne, 1950.

Dannevig, G. "Sprat from Norwegian waters. An analysis of vertebrae counts". Fiskeridirek. Skr., Ser. Havunders., **9**, 12, Bergen, 1951.

Letaconnoux, R. "Une expérience de marquage sur la sardine du Golfe de Gascogne". Cons. Perm. Internat. Explor. Mer, Journ. du Cons., **17**, 3, pp. 264—6, Copenhague, 1951.

Nair, R. V. & Chidambaram, K. "A review of the Indian oil sardine fishery". Proc. Nation. Inst. Sci. India, **17**, 1, pp. 71—85, Madras, 1951.

8) l Tunny and Mackerel.

Brock, V. E. "A preliminary report on *Parathunnus sibi* in Hawaiian waters and a key to the tunas and tuna-like fishes of Hawaii". Pacific. Sci., **3**, 3, pp. 271—7, Honolulu, 1949.

Gall, J. le. "Ichthyométrie des Thonidés. De l'emploi d'une technique internationale". Cons. Perm. Internat. Explor. Mer, Journ. du Cons., **17**, 3, pp. 267—73, Copenhague, 1951.

Schaefer, M. B. & Walford, L. A. "Biometric comparison between yellowfin tuna (*Neothunnus*) of Angola and of the Pacific coast of Central America". U.S. Dept. Int., Fish & Wildl. Serv., Fish. Bull. 56, Washington, 1950.

8) m Other Commercial Species.

Bougis, P. "Sur un allongement des nageoires pectorales corrélatif d'un changement de milieu, chez les jeunes *Mullus*". Vie et Milieu, **1**, 2, pp. 243—7, Paris, 1950.

Rae, B. B. "A comparison of the pre-war and post-war stocks of lemon soles at Faroe". Cons. Perm. Internat. Explor. Mer, Journ. du Cons., **17**, 3, pp. 242—60, Copenhague, 1951.

Tortonese, E. "Studi sui Plagiostomi (IV. Materiali per una revisione dei *Carcharhinus* mediterranei)". Boll. Pesca, Piscicolt. e Idrobiol., Ann. 26, **5**, 1, pp. 5—21, Roma, 1950.

Zei, M. "Jadranske Girice *(Maenidae)*. Monografska studija". Acad. Sci. Artium Slovenica, Class. IV, Hist., Natur. Med., 4, Ljubljana, 1951.

8) o Whales and Seals.

Fisher, H. D. "Seals of the Canadian east coast". Fish. Res. Board Canada, Atlant. Biol. Stat., Circ. Gen. Ser., 18, St. Andrews, N.B., 1950.

Jonsgård, Å. "Studies on the little piked whale or minke whale (*Balaenoptera acuto-rostrata* Lacépède). Report on Norwegian investigations carried out in the years 1943—50". Norw. Whaling Gaz., 5, Sandefjord, 1951.

Nishiwaki, M. "Determination of the age of Antarctic blue and fin whales by the colour changes in crystalline lens". Sci. Rep. Whales Res. Inst., 4, pp. 115—61, Tokyo, 1950.

Nishiwaki, M. "Age characteristics in balean plates". ibid., 4, pp. 162—83, Tokyo, 1950.

Nishiwaki, M. "On the body weight of whales". Sci. Rep. Whales Res. Inst., 4, pp. 184—209, Tokyo, 1950.

Omura, H. "On the body weight of sperm and sei whales located in the adjacent waters of Japan". Sci. Rep. Whales Res. Inst., 4, pp. 1—13, Tokyo, 1950.

Omura, H. "Diatom infection on blue and fin whales in the Antarctic whaling area V (the Ross Sea area)". Sci. Rep. Whales Res. Inst., 4, pp. 14—26, Tokyo, 1950.

Omura, H. "Whales in the adjacent waters of Japan". ibid., 4, pp. 27—113, Tokyo, 1950.

Rittinghaus, H. "Seehunde an unsrer Nordsee-Küste". Natur u. Volk, **80**, 9/10, pp. 275—7, Frankfurt a. M., 1950.

Schubert, K. "Über das Vorkommen des Pottwals (*Physeter macrocephalus* L.) an der Peruküste". Mitt. Inst. Seefisch., 2, pp. 30—51, Hamburg, 1950.

9) Freshwater Fisheries and Fishery Investigations.

9) a Salmonidae.

Alm, G. "The sea trout population in the Ava stream". Inst. Freshw. Res., Drottningholm, Rep. 31, pp. 26—56, Lund, 1950.

Barrett, I. "Fertility of salmonoid eggs and sperm after storage". Journ. Fish. Res. Board Canada, **8**, 3, pp. 125—33, Toronto, 1951.

Black, V. S. "Changes in body chloride, density, and water content of chum *(Oncorhynchus keta)* and coho *(O. kisuch)* salmon fry when transferred from fresh water to sea water". Journ. Fish. Res. Board Canada, **8**, 3, pp. 164—77, Toronto, 1951.

Brett, J. R. "A study of the Skeena river climatological conditions with particular reference to their significance in sockeye production". Journ. Fish. Res. Board Canada, **8**, 3, pp. 178—87, Toronto, 1951.

Elson, P. F. "Increasing salmon stocks by control of mergansers and kingfishes". Prog. Rep. Atlantic Coast Stat., 51, pp. 12—5, St. Andrews, N.B., 1950.
Jackson, R. I. "Variations in flow patterns at Hell's Gate and their relationships to the migration of sockeye salmon". Internat. Pacific Salmon Fish. Comm., Bull. 3, 2, New Westminster, B.C., 1950.
Määr, A. "A supplement to the fertility of char (*Salmo alpinus* L.) in the Faxälven watersystem, Sweden". Inst. Freshwater Res., Drottningholm, Rep. 31, pp. 127—36, Lund, 1950.
Talbot, G. B. "A biological study of the effectiveness of the Hell's Gate fishways". Internat. Pacific Salmon Fish. Comm., Bull. 3, 1, New Westminster, B.C., 1950.
Went, A. E. J., O'Driscoll, D. & Toner, E. D. "Movements of salmon in the sea". Sci. Invest. Dept. Fish. Ireland, **46**, pp. 2—12, Dublin, 1949.

9) b Eels.

Lowe, R. H. "Factors influencing the runs of elvers in the river Bann, Northern Ireland". Cons. Perm. Internat. Explor. Mer, Journ. du Cons., **17**, 3, pp. 299—315, Copenhague, 1951.
Schnakenbeck, W. "Untersuchungen über Fragen um den Aal". Mitt. Inst. Seefisch., 2, pp. 1—29, Hamburg, 1950.

9) c Other Commercial Species.

Järvi, T. H. "Die Kleinmaränenbestände in ihren Beziehungen zu der Umwelt (*Coregonus albula* L.)". Acta Zool. Fennica, 61, pp. 1—116, Helsingfors 1950.
Johanson, A. "The white-fish population of Lake Ocke". Inst. Freshw. Res., Drottningholm, Rep. 31, pp. 100-9, Lund, 1950.
Makhmudbekov, A. A. "Caspian shad (*Caspialosa* spp.)". Priroda, 9, p. 72, Moscow, 1949. (In Russian).
Oosten, J. van. "The age, growth, sexual maturity and sex ratio of the common whitefish *Coregonus clupeaformis* (Mitchill), of Lake Huron". Pap. Michigan Acad.. Sci., Arts & Letters, **24**, 2, pp. 195—221, New York, 1939.
Oosten, J. van. "Relationship between the plantings of fry and production of whitefish in Lake Eerie". Trans. Amer. Fish. Soc., **71**, Washington, 1942.
Svärdson, G. "The Coregonid problem II. Morphology of two Coregonid species in different environments". Inst. Freshw. Res., Drottningholm, Rep. 31, pp. 151—62, Lund, 1950.
Wunder, W. "Fortschrittliche Karpfenteichwirtschaft". E. Schweizerbart'sche Verlagsbuchh., Stuttgart, 1949.

9) d Effects of Pollution.

Hasler, A. D. & Wisby, W. J. "Use of fish for the olfactory assay of pollutants (phenols) in water". Trans. Amer. Fish. Soc., **79**, pp. 64—70, New York, 1950.
Oosten, J. van. "Turbidity as a factor in the decline of Great Lakes fishes with special reference to Lake Eerie". Trans. American Fish. Soc., **75**, pp. 281—322, New York, 1948.

9) e Ecology.

Alm, G. "Preliminary report of certain experiments with a view to exploiting lakes empty of fish". Inst. Freshw. Res., Drottningholm, Rep. 31, pp. 19—25, Lund, 1950.
Lund, J. W. G. "Studies on *Asterionella*. 1. The origin and nature of the cells producing seasonal maxima". Journ. Ecol., **37**, 2, pp. 389—419, London, 1949.
Parkhurst, Z. E. "Survey of the Columbia River and its tributaries. Part 6, Area 5 — Snake River system from the mouth through the Grande Ronde River". U.S. Dept. Int., Fish and Wildl. Serv., Spec. Sci. Rep. Fish., 39, Washington, 1950.
Sugahara, K. et al. "Investigations on the productivity in Lake Suwa and Tokyo Bay". Journ. Fish. Res. Inst., 2, pp. 1—33, Tokyo, 1949.

10) Shellfisheries.

10) a Molluscs.

Chambers, J. S. & Magnusson, H. W. "Seasonal variations in toxicity of butter clams from selected Alaska beaches". U.S. Dept. Int., Fish. Wildl. Serv., Spec. Sci. Rep. Fish., 53, Washington, 1950.

Korringa, P. "De aanval van de parasiet *Mytilicola intestinalis* op de Zeeuwse Mosselcultuur". Suppl. Visserij-Nieuws, 7, 's-Gravenhage, 1950.
Korringa, P. "A review of the papers on molluscs presented at the Special Scientific Meeting on Shellfish of the International Council for the Exploration of the Sea, Edinburgh, 1949". Cons. Perm. Internat. Explor. Mer, Journ. du Cons., **17**, 1, pp. 44—59, Copenhague, 1950.
Owen, H. M., Walters, L. L. — Bregan, L. A. "Etiological studies on oyster mortality. I. *Nematopsis ostrearum* Prytherch 1940 (Sporazoa: Porosporidae)". Journ. Mar. Res., **10**, 1, pp. 82—90, New Haven, Conn., 1951.

10) b Crustacea.

Creaser, E. P. & Travis, D. "Evidence of a homing instinct in the Bermuda spiny lobster". Science, **112**, 2902, Lancaster, Pa., 1950.
Reinke, W. "Zur Krabbenfischerei zwischen Weser und Ems". Fischereiwelt, **2**, 11, pp. 161—2, Bremerhaven u. Hamburg-Altona, 1950.

11) Miscellaneous.

11) a General.

Anon. "Sea Fish Industry Bill". Bill 58, H.M.S.O., London, 1950.
Anon. "Jahresheft der deutschen Fischwirtschaft 1951". Hamburg, 1951.
Brock, F. "Der Köder als fischereibiologisches Problem". Arch. f. Fisch. Wiss., **2**, 1/2, pp. 74—8, Hamburg, 1950.
Carruthers, J. N. "An attitude on 'Fishery Hydrography'". Journ. Mar. Res., **10**, 1, pp. 101—18, New Haven, 1951.
Fields, W. G. "A preliminary report on the fishery and on the biology of the squid *Loligo opalescens*". Calif. Fish & Game, **36**, 4, pp. 366—77, San Francisco, 1950.
Gellert, J. F. "Die geographischen Namen in der Sowjetarktis und ihre Wiedergabe im Englischen". Petermanns Geogr. Mitt., **95**, 2, pp. 111—3. Gotha, 1951.
Gowanloch, J. N. "The effects of underwater seismographic exploration". Proc. Gulf & Carib. Fish. Inst., 2 Ann. Sess., pp. 105—6, Univ. Miami, Florida, 1950.
Greenwood, P. H. "Evolution of the African Cichlid fishes: the *Haplochromis* species-flock in Lake Victoria". Nature, **167**, 4236, pp. 19—20, London, 1950.
Hiscock, I. D. "Shell movements of the freshwater mussel, *Hyridella australis* Lam. (Lamellibranchiata)". Austral. Journ. Mar. Freshw. Res., **1**, 2, pp. 259—67, Melbourne, 1950.
Hornell, J. "Fishing in many waters". C.U.P., Cambridge, 1950.
Jansen, A. "Bibliografie indonesische visserij". Berita Perikanan, **2**, 9, pp. 138—9, Djakarta, 1950.
King, H. K. "Penicillin in the aquarium". Nature, **166**, 4233, p. 1036, London, 1950.
Marshall, N. B. "Bathypelagic fishes as sound scatterers in the ocean". Journ. Mar. Res., **10**, 1, pp. 1—17, New Haven, Conn., 1951.
Myers, G. S. & Wade, C. B. "New fishes of the families Dactyloscopidae, Microdesmidae, and Antennariidae from the west coast of Mexico and the Galapagos Islands with a brief account of the rise of rotenone fish poisons in ichthyological collecting". Allan Hancock Pacific Exped., **9**, 6, Los Angeles, 1946.
Richter, R. "Einführung in die zoologische Nomenklatur durch Erläuterung der internationalen Regeln". Kramer, 252 pp., Frankfurt a. M., 1948.
Schäfer, W. "Seewasser-Aquarium in Wilhelmshaven". Natur u. Volk, **80**, 11/12, pp. 309—20, Frankfurt a. M., 1950.
Schubart, O. "A pesca nos estados de Pernambuco e Alagoas". Min. Agric., Dept. Nac. Prod. Anim., Div. Caça e Pesca, Rio de Janeiro, 1944.
Wales, J. H., Murphey, E. W. & Handley, J. "Perforated plate fish screens". Calif. Fish & Game, **36**, 4, pp. 392—403, San Francisco, 1950.

11) b Mathematical and Statistical Methods.

Barnes, H. "A statistical study of the variability of catches obtained with two models of the Hardy Plankton Indicator". Hull Bull. Mar. Ecol. **2**, 16, pp. 283—93, Hull, 1951.
McEwen, G. F. "The reality of regularities indicated in sequences of observations". Proc. Berkeley Symp. Math. Stats. Probability, 1949, pp. 229—38, Berkeley & Los Angeles, 1949.

Recent Publications of the International Council:

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pour l'année 1948. Février 1952. Kr. 8.00.
pour l'année 1949. In preparation.

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